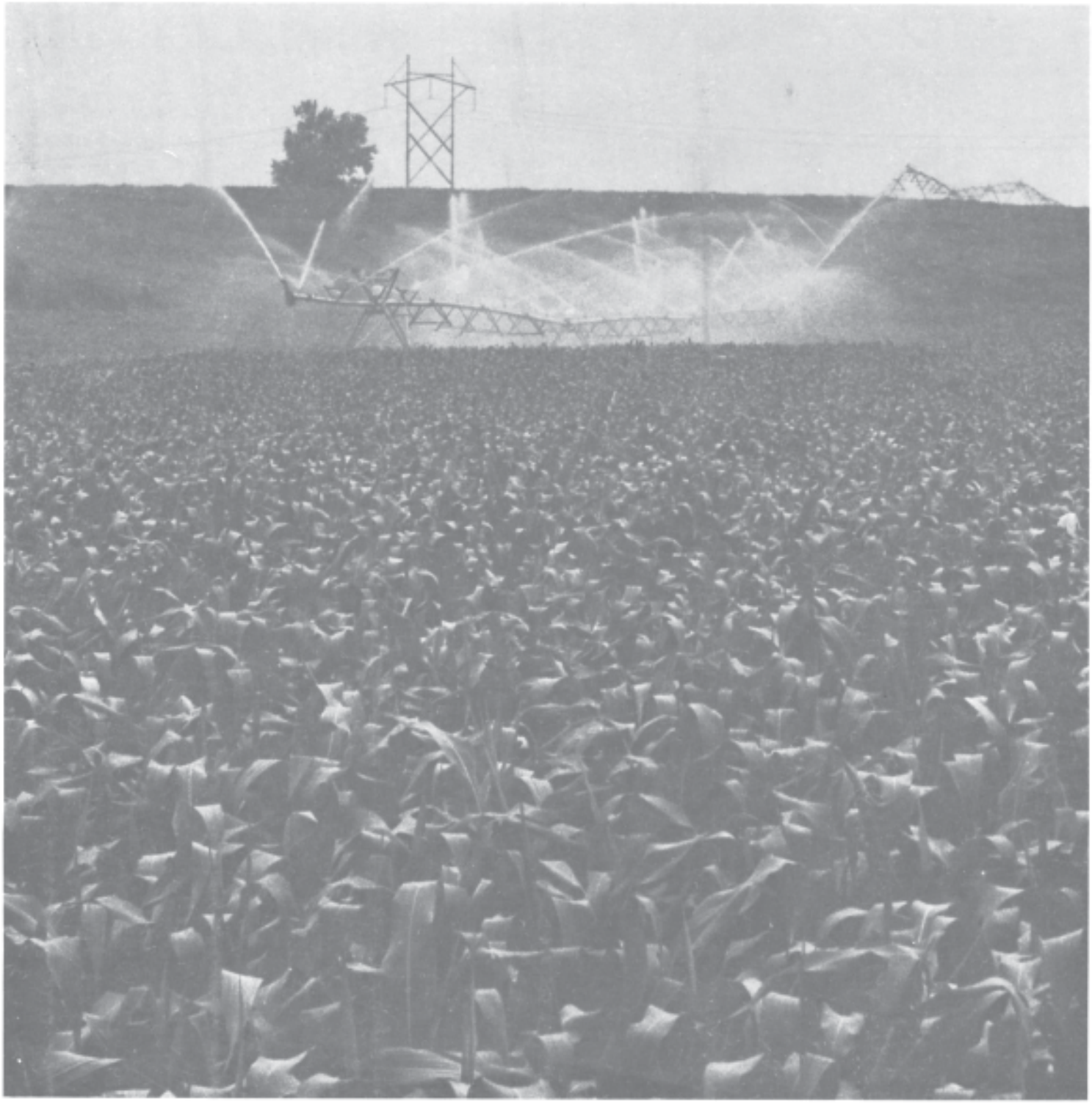
United States
Department of
Agriculture

Soil
Conservation
Service

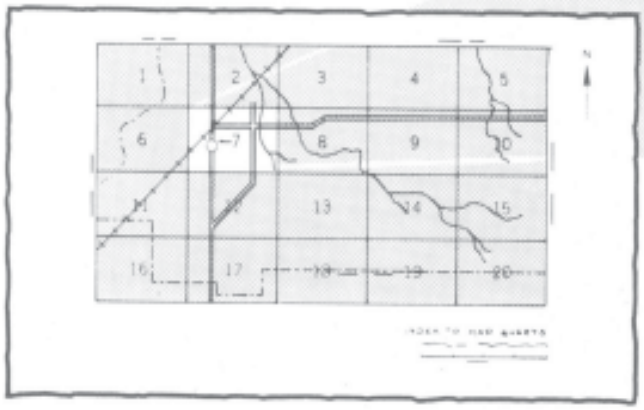
In cooperation
with the
Minnesota Agricultural
Experiment Station

Soil Survey of Dakota County Minnesota



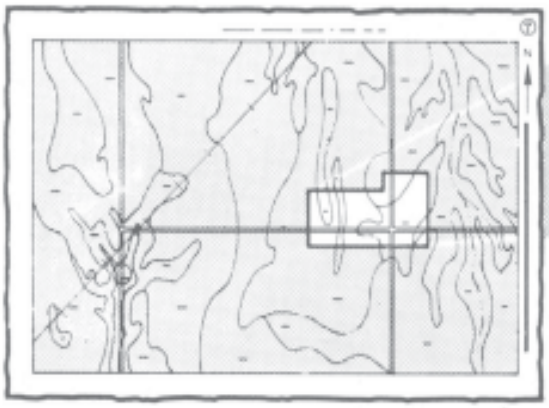
HOW TO USE

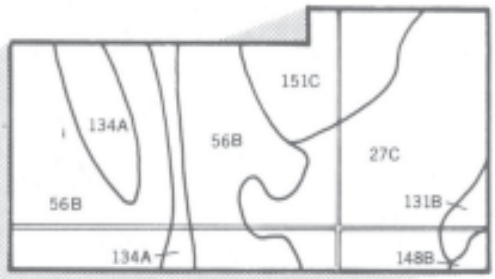
1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).



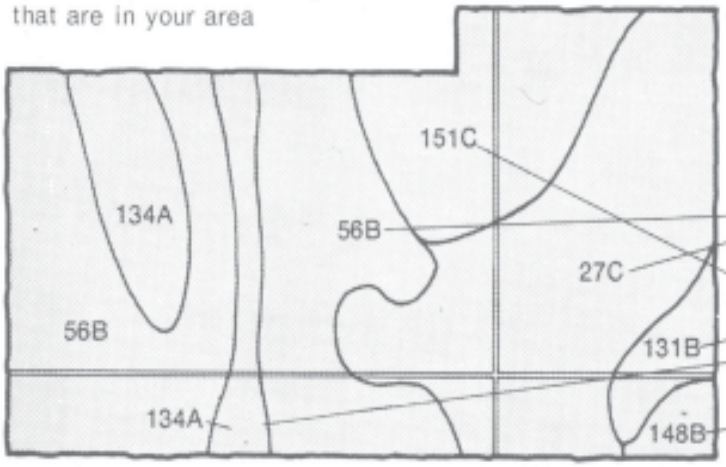
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.





4. List the map unit symbols that are in your area

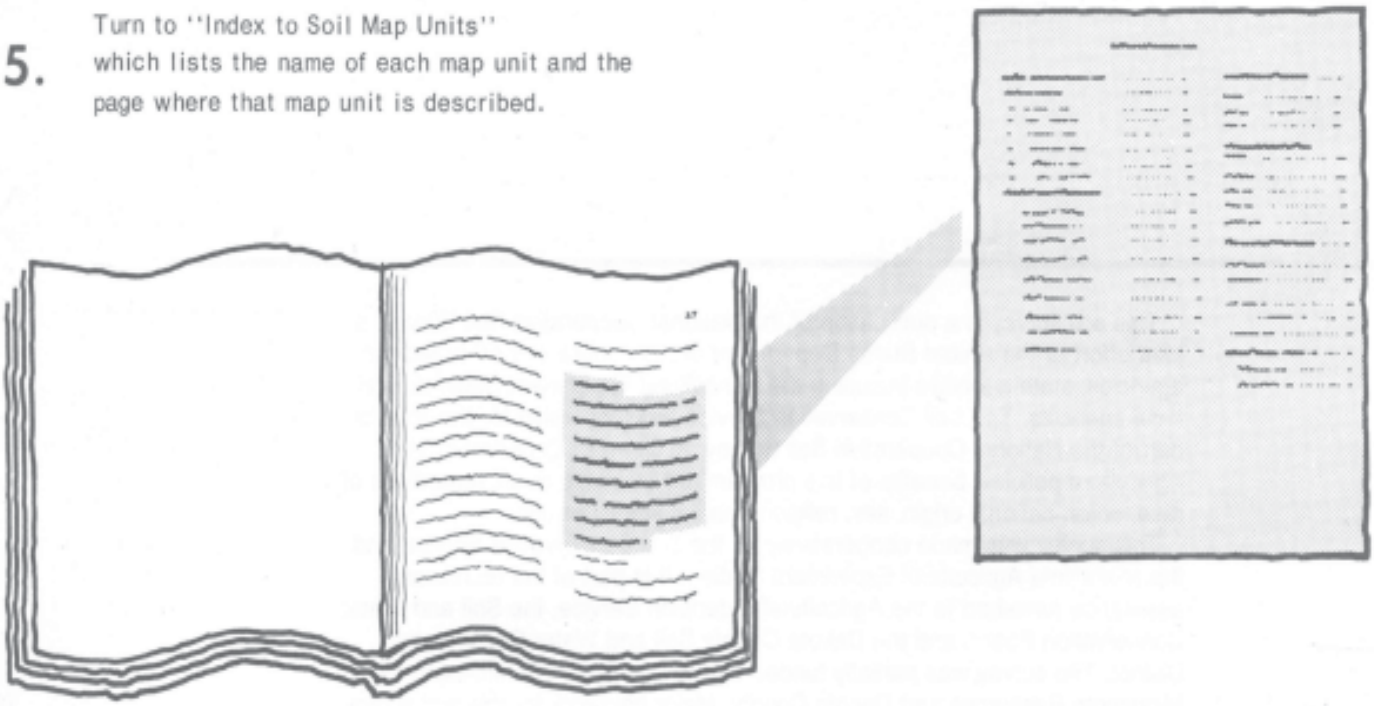


Symbols

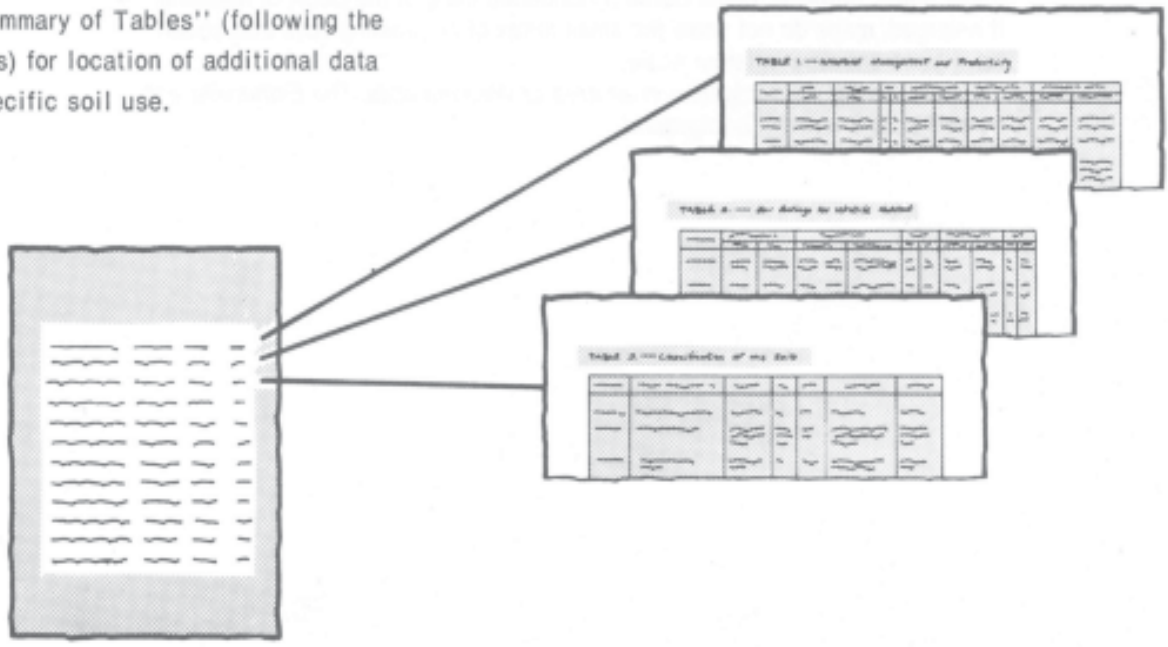
27C
56B
131B
134A
148B
151C

THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. 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.

This survey was made cooperatively by the Soil Conservation Service and the Minnesota Agricultural Experiment Station. It is part of the technical assistance furnished to the Agricultural Extension Service, the Soil and Water Conservation Board, and the Dakota County Soil and Water Conservation District. The survey was partially funded by the Legislative Commission for Minnesota Resources and Dakota County. Major fieldwork for this soil survey was performed in the period 1974–1979. Soil names and descriptions were approved in 1980. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1980.

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: Center pivot irrigation in an area of Wadena soils. The Estherville and Hawick soils are in the background.

contents

Index to map units v
Summary of tables vii
Foreword ix
General nature of the county 2
How this survey was made 3
General soil map units 5
Soil descriptions 5
Detailed soil map units 17
Soil descriptions 17
Prime farmland 90
Use and management of the soils 93
Crops and pasture 93
Woodland management and productivity 96
Woodland understory vegetation 97
Windbreaks and environmental plantings 97
Recreation 97
Wildlife habitat 98
Engineering 99
Soil properties 105
Engineering index properties 105
Physical and chemical properties 106
Soil and water features 107
Classification of the soils 109
Soil series and their morphology 109
Formation of the soils 147
Factors of soil formation 147
Geology 149
References 151
Glossary 153
Tables 163

soil series

Algansee series 109
Antigo series 110
Auburndale series 110
Blooming series 111
Bold series 112
Boone series 112
Boots series 112
Brodale series 113
Burkhardt series 113
Carmi series 114
Chetek series 114
Colo series 115
Copaston series 115
Cordova series 116
Crystal Lake series 116
Cylinder series 117
Dickinson series 118
Emmert series 118
Estherville series 119
Etter series 119
Faxon series 120
Frontenac series 120
Garwin series 121
Glencoe series 121
Gotham series 122
Hamel series 122
Hawick series 123
Hubbard series 124
Jewett series 124
Joy series 125
Kalmarville series 125
Kanaranzi series 126
Kato series 126
Kennebec series 126
Kennebec Variant 127
Kingsley series 127
Klinger series 128
Lawson series 129
Le Sueur series 129
Lester series 130
Lindstrom series 130
Mahtomedi series 131
Marlean series 131
Marshan series 131
Maxcreek series 132
Maxfield series 133
Mayer series 133
Merton series 134
Minneiska series 134
Oshawa series 135
Ostrander series 135
Otterholt series 136
Palms series 136
Plainfield series 137
Port Byron series 137
Quam series 138
Rockton series 138

Rondeau series 139
Salida series 139
Seelyeville series 140
Sparta series 140
Spencer series 141
Spillville series 141
Tallula series 142
Terril series 142
Timula series 142
Wadena series 143
Waukegan series 143
Webster series 144
Winnebago series 145
Zumbro series 145

Issued April 1983

index to map units

2B—Ostrander loam, 1 to 6 percent slopes 17
2C—Ostrander loam, 6 to 12 percent slopes..... 18
7A—Hubbard loamy sand, 0 to 1 percent slopes..... 18
7B—Hubbard loamy sand, 1 to 6 percent slopes..... 19
7C—Hubbard loamy sand, 6 to 12 percent slopes..... 19
7D—Hubbard loamy sand, 12 to 18 percent slopes... 20
8A—Sparta loamy fine sand, 0 to 1 percent slopes... 20
8B—Sparta loamy fine sand, 1 to 6 percent slopes... 21
12C—Emmert very gravelly sandy loam, 3 to 15 percent slopes 21
27A—Dickinson sandy loam, 0 to 2 percent slopes... 21
27B—Dickinson sandy loam, 2 to 6 percent slopes... 22
39A—Wadena loam, 0 to 2 percent slopes..... 23
39B—Wadena loam, 2 to 6 percent slopes..... 23
39B2—Wadena loam, 2 to 6 percent slopes, eroded 23
39C—Wadena loam, 6 to 12 percent slopes..... 24
39C2—Wadena loam, 6 to 12 percent slopes, eroded..... 24
39D—Wadena loam, 12 to 18 percent slopes 25
41A—Estherville sandy loam, 0 to 2 percent slopes.. 25
41B—Estherville sandy loam, 2 to 6 percent slopes.. 26
42C—Salida gravelly coarse sandy loam, 2 to 12 percent slopes 26
49B—Antigo silt loam, 1 to 8 percent slopes..... 27
81B—Boone loamy fine sand, 2 to 6 percent slopes. 27
81C—Boone loamy fine sand, 6 to 12 percent slopes..... 28
81E—Boone loamy fine sand, 12 to 40 percent slopes..... 28
94C—Terril loam, 4 to 12 percent slopes 29
98—Colo silt loam, occasionally flooded 29
100A—Copaston loam, 0 to 2 percent slopes 30
100B—Copaston loam, 2 to 6 percent slopes 30
100C—Copaston loam, 6 to 12 percent slopes 31
106B—Lester loam, 2 to 6 percent slopes 31
106C—Lester loam, 6 to 12 percent slopes..... 31
106C2—Lester loam, 6 to 12 percent slopes, eroded..... 32
106D2—Lester loam, 12 to 18 percent slopes, eroded..... 32
109—Cordova silty clay loam 33
113—Webster clay loam 33
114—Glencoe silty clay loam 34
129—Cylinder loam..... 34
150B—Spencer silt loam, 2 to 6 percent slopes 35
151C—Burkhardt sandy loam, 6 to 12 percent slopes..... 35
151D—Burkhardt sandy loam, 12 to 18 percent slopes..... 36
155B—Chetek sandy loam, 3 to 8 percent slopes 36
155C—Chetek sandy loam, 8 to 15 percent slopes... 37
155E—Chetek sandy loam, 15 to 25 percent slopes. 37
173F—Frontenac loam, 25 to 40 percent slopes 38
176—Garwin silty clay loam..... 38
177A—Gotham loamy fine sand, 0 to 2 percent slopes..... 39
177B—Gotham loamy fine sand, 2 to 6 percent slopes..... 39
177C—Gotham loamy fine sand, 6 to 12 percent slopes..... 40
189—Auburndale silt loam 40
203B—Joy silt loam, 1 to 5 percent slopes..... 41
208—Kato silty clay loam..... 41
213B—Klinger silt loam, 1 to 5 percent slopes..... 42
226—Lawson silt loam 42
239—Le Sueur loam 42
250—Kennebec silt loam 43
251D—Marlean loam, 12 to 18 percent slopes 43
251E—Marlean loam, 18 to 25 percent slopes..... 44
252—Marshan silty clay loam..... 44
253—Maxcreek silty clay loam 45
255—Mayer silt loam 45
279B—Otterholt silt loam, 1 to 6 percent slopes..... 46
279C—Otterholt silt loam, 6 to 15 percent slopes..... 46
283A—Plainfield loamy sand, 0 to 2 percent slopes.. 46
283B—Plainfield loamy sand, 2 to 6 percent slopes.. 47
283D—Plainfield loamy sand, 6 to 18 percent slopes 47
285A—Port Byron silt loam, 0 to 2 percent slopes 48
285B—Port Bryon silt loam, 2 to 6 percent slopes 48
285C—Port Bryon silt loam, 6 to 12 percent slopes .. 49
299A—Rockton loam, 0 to 2 percent slopes 49
299B—Rockton loam, 2 to 6 percent slopes 49
299C—Rockton loam, 6 to 12 percent slopes 50
301B—Lindstrom silt loam, 1 to 4 percent slopes..... 50
313—Spillville loam, occasionally flooded 51
317—Oshawa silty clay loam..... 51
318—Mayer loam, swales 51
320B—Tallula silt loam, 2 to 6 percent slopes..... 52
320C2—Tallula silt loam, 6 to 12 percent slopes, eroded..... 52
342B—Kingsley sandy loam, 3 to 8 percent slopes... 53
342C—Kingsley sandy loam, 8 to 15 percent slopes. 53
342E—Kingsley sandy loam, 15 to 25 percent slopes..... 54
342F—Kingsley sandy loam, 25 to 40 percent slopes..... 54
344—Quam silt loam 55
377B—Merton silt loam, 1 to 6 percent slopes..... 55

378—Maxfield silty clay loam 55
382B—Blooming silt loam, 1 to 6 percent slopes..... 56
408—Faxon silty clay loam 56
409B—Etter fine sandy loam, 2 to 6 percent slopes.. 57
409C—Etter fine sandy loam, 6 to 12 percent slopes 57
411A—Waukegan silt loam, 0 to 1 percent slopes..... 58
411B—Waukegan silt loam, 1 to 6 percent slopes..... 59
411C—Waukegan silt loam, 6 to 12 percent slopes .. 59
414—Hamel silt loam..... 60
415A—Kanaranzi loam, 0 to 2 percent slopes..... 60
415B—Kanaranzi loam, 2 to 6 percent slopes..... 61
415C—Kanaranzi loam, 6 to 12 percent slopes 62
449B—Crystal Lake silt loam, 1 to 8 percent slopes . 62
454B—Mahtomedi loamy sand, 3 to 8 percent slopes..... 63
454C—Mahtomedi loamy sand, 8 to 15 percent slopes..... 63
454E—Mahtomedi loamy sand, 15 to 25 percent slopes..... 63
463—Minneiska loam, occasionally flooded..... 64
465—Kalmarville sandy loam, frequently flooded..... 64
495—Zumbro fine sandy loam 65
522—Boots muck..... 66
539—Palms muck 66
540—Seelyeville muck..... 66
545—Rondeau muck 67
611C—Hawick coarse sandy loam, 6 to 12 percent slopes..... 67
611D—Hawick coarse sandy loam, 12 to 18 percent slopes..... 68
611E—Hawick loamy sand, 18 to 25 percent slopes. 68
611F—Hawick loamy sand, 25 to 50 percent slopes. 69
857A—Urban land-Waukegan complex, 0 to 1 percent slopes 69
857B—Urban land-Waukegan complex, 1 to 8 percent slopes 70
858C—Urban land-Chetek complex, 1 to 15 percent slopes..... 70
860C—Urban land-Lester complex, 3 to 15 percent slopes..... 70
861C—Urban land-Kingsley complex, 3 to 15 percent slopes 71
861E—Urban land-Kingsley complex, 15 to 25 percent slopes 71
865B—Urban land-Hubbard complex, 0 to 6 percent slopes..... 72
880F—Brodale-Rock outcrop complex, 18 to 45 percent slopes 72
888B—Kingsley-Lester complex, 2 to 6 percent slopes..... 73
888C—Kingsley-Lester complex, 6 to 12 percent slopes..... 74
888D—Kingsley-Lester complex, 12 to 18 percent slopes..... 75
889B—Wadena-Hawick complex, 2 to 6 percent slopes..... 75
889C—Wadena-Hawick complex, 6 to 12 percent slopes..... 76
889D—Wadena-Hawick complex, 12 to 18 percent slopes..... 76
895B—Kingsley-Mahtomedi-Spencer complex, 3 to 8 percent slopes 77
895C—Kingsley-Mahtomedi-Spencer complex, 8 to 15 percent slopes..... 78
896E—Kingsley-Mahtomedi complex, 15 to 25 percent slopes 79
896F—Kingsley-Mahtomedi complex, 25 to 40 percent slopes 79
963C2—Timula-Bold silt loams, 6 to 12 percent slopes, eroded 80
963D2—Timula-Bold silt loams, 12 to 18 percent slopes, eroded 81
963E2—Timula-Bold silt loams, 18 to 25 percent slopes, eroded 81
1013—Pits, quarry..... 82
1027—Udorthents, wet..... 82
1029—Pits, gravel 82
1039—Urban land 83
1055—Aquolls and Histosols, ponded..... 83
1072—Udorthents, moderately shallow..... 83
1815—Zumbro loamy fine sand 83
1816—Kennebec Variant silt loam..... 84
1821—Algansee sandy loam, occasionally flooded ... 84
1824—Quam silt loam, ponded..... 85
1825C—Seelyeville muck, sloping 85
1827A—Waukegan silt loam, bedrock substratum, 0 to 2 percent slopes 85
1827B—Waukegan silt loam, bedrock substratum, 2 to 6 percent slopes 86
1827C—Waukegan silt loam, bedrock substratum, 6 to 12 percent slopes 86
1848B—Sparta loamy sand, bedrock substratum, 2 to 8 percent slopes 87
1894B—Winnebago loam, 2 to 6 percent slopes 87
1895B—Carmi loam, 2 to 8 percent slopes..... 88
1896B—Ostrander-Carmi loams, 2 to 6 percent slopes..... 88
1898F—Etter-Brodale complex, 25 to 60 percent slopes..... 89
1902B—Jewett silt loam, 1 to 6 percent slopes 89

summary of tables

Temperature and precipitation (table 1) 164

Freeze dates in spring and fall (table 2) 165
Probability. Temperature.

Growing season (table 3) 166
Probability. Daily minimum temperature.

Acreage and proportionate extent of the soils (table 4) 167
Acres. Percent.

Yields per acre of crops and pasture (table 5) 170
Corn. Soybeans. Oats. Grass-legume hay. Bromegrass-alfalfa. Kentucky bluegrass.

Woodland management and productivity (table 6) 177
Ordination symbol. Management concerns. Potential productivity. Trees to plant.

Windbreaks and environmental plantings (table 7) 182

Recreational development (table 8) 193
Camp areas. Picnic areas. Playgrounds. Paths and trails. Golf fairways.

Wildlife habitat (table 9) 202
Potential for habitat elements. Potential as habitat for—Openland wildlife, Woodland wildlife, Wetland wildlife.

Building site development (table 10) 209
Shallow excavations. Dwellings without basements. Dwellings with basements. Small commercial buildings. Local roads and streets. Lawns and landscaping.

Sanitary facilities (table 11) 218
Septic tank absorption fields. Sewage lagoon areas. Trench sanitary landfill. Area sanitary landfill. Daily cover for landfill.

Construction materials (table 12) 228
Roadfill. Sand. Gravel. Topsoil.

Water management (table 13) 236
Limitations for—Pond reservoir areas; Embankments, dikes, and levees. Features affecting—Drainage, Irrigation, Terraces and diversions, Grassed waterways.

Engineering index properties (table 14) 244
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 15) 254
Depth. Clay. Moist bulk density. Permeability. Available water capacity. Reaction. Shrink-swell potential. Erosion factors. Wind erodibility group. Organic matter.
Water features (table 16) 261
Hydrologic group. Flooding. High water table.
Soil features (table 17) 266
Bedrock. Subsidence. Potential frost action. Risk of corrosion.
Classification of the soils (table 18) 271
Family or higher taxonomic class.

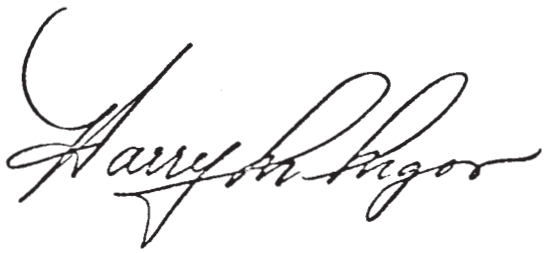
foreword

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

This soil survey is designed for many different users. Farmers, ranchers, 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.



Harry M. Major
State Conservationist
Soil Conservation Service

This page intentionally left blank.

soil survey of
Dakota County, Minnesota

By Steven J. Hundley, Soil Conservation Service

Fieldwork by Steven J. Hundley, Keith A. Christensen, Robert Lueth, and Gerald W. McCormick, Soil Conservation Service; and Terry L. Bovee, Tim R. Fredbo, and Kim K. Gordenier, Minnesota Agricultural Experiment Station

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

DAKOTA COUNTY is the southeastern part of Minnesota near the junction of the Minnesota and Mississippi Rivers (fig. 1). Its land area is approximately 576 square miles, or 368,640 acres. The Minnesota River forms its northwestern boundary and the Mississippi River its northern and northeastern boundaries. Scott County is on the west, Ramsey County on the north, Rice County on the south, and Goodhue County on the south and east.

Dakota County contains 20 townships or parts of townships. The city of Hastings is the county seat. Other important towns are Farmington, Lakeville, Rosemount, South St. Paul, and West St. Paul (*9*). The northern quarter of the county is mainly urban, and the southern three-quarters is dominantly rural.

In 1970 the population of the county was 49,019. Of this number 31,301, or 64 percent, was classed as urban and 17,718, or 36 percent, as rural.

Farmland makes up about 62 percent of Dakota County. About 3 percent is woodland. The remaining 35 percent is mostly urban land or idle.

Corn is the major crop in Dakota County. Other important crops include soybeans, hay, wheat, oats, and vegetables. About 7 percent of the agricultural land is pasture. The irrigating of crops is rapidly increasing.

Dakota County contains a large number of distinctly different soils. Most of these soils formed in glacial

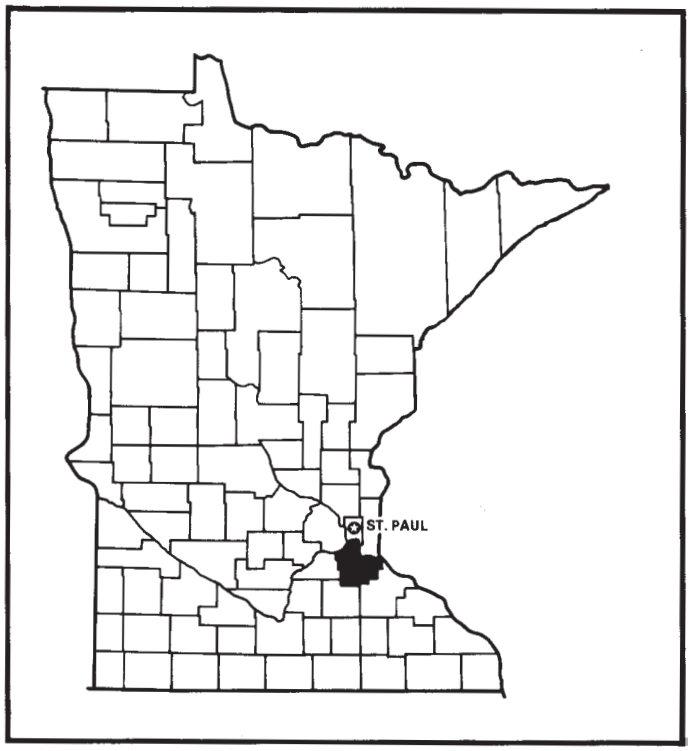


Figure 1.—Location of Dakota County in Minnesota.

deposits or loess that varies in properties and age. Some soils formed in weathered bedrock and recent alluvium.

These soils range from light colored to dark colored and level to very steep. They formed under original vegetation of tall-grass prairie and mixed deciduous hardwood forest.

A survey of Dakota County was published (*7*) in 1960. This present survey updates the earlier survey and provides additional information and larger maps that show the soils in greater detail.

general nature of the county

This section gives general information about Dakota County. It consists of briefs on climate, physiography, relief, and drainage.

climate

Dakota County is cold in winter and quite hot with occasional cool periods in summer. Precipitation during the winter frequently occurs as snowstorms; and during the warm months, it is mainly showers, often heavy, that occur when warm, moist air moves in from the south. Total annual rainfall is normally adequate for corn, soybeans, and small grains.

Occasional tornadoes and severe thunderstorms are local and of short duration. They result in sparse damage in narrow belts. Hailstorms occur during the warmer part of the year in irregular patterns and in relatively small areas.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Farmington, Minnesota, in the period 1951 to 1974. 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 7 degrees. The lowest temperature on record, which occurred at Farmington on January 15, 1972, is minus 36 degrees. In summer the average temperature is 70 degrees, and the average daily maximum temperature is 81 degrees. The highest recorded temperature, which occurred on June 30, 1963, is 99 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." Beginning in the spring, 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.

Of the total annual precipitation, 21 inches, or 70 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 18 inches. The heaviest 1-day rainfall during the period of record was 5.10 inches at Farmington on July 8, 1955. Thunderstorms occur on about 36 days each year, and 22 occur in summer.

Average seasonal snowfall is 41 inches. The greatest snow depth at any one time during the period of record was 36 inches. On an average of 43 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 in summer and 45 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 12 miles per hour, in April.

physiography, relief, and drainage

Dakota County is a geologically complex area. It includes several distinct geomorphic regions.

The northwestern and western parts of the county consist of complex moraines. The topography is hilly and irregular. There are many deep depressions that are poorly drained. Most of the natural lakes in Dakota County are in this area.

A large area in the central and eastern parts of the county and parts of the extreme south are level to gently rolling outwash plains. A few short, steep escarpments separate terraces along the Mississippi River. Most of these areas are well drained; however, some areas in the central part of the county are poorly drained, and several have large peat bogs.

Much of the southern part of the county has gently sloping topography controlled by bedrock. In some places, bedrock buttes stand 100 feet or more above the surrounding areas. Most of the bedrock is covered by thin layers of silty or loamy sediments. Short, steep slopes of bedrock are common across much of the area; but long, very steep slopes are common in the extreme southeast.

Along the Mississippi and Minnesota Rivers are extensive flood plains. Most are nearly level and poorly drained. Oxbow lakes and bogs are common.

The Mississippi and Minnesota Rivers drain the northern part of the county. The Vermillion River drains the central part. The extreme southern part of the county is drained by the Cannon River.

The highest elevations in the county are on the moraines in the northern and western areas. Buck Hill, the highest point in the county, has an elevation of 1,195 feet. Most of the county slopes toward the east. It drops from an average elevation of about 1000 feet in the west and south to about 800 feet at the top of the Mississippi River Valley. The lowest elevation, about 675 feet, occurs where the Mississippi River leaves the county.

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, woodland managers, engineers, planners, developers and builders, home buyers, and others.

This page intentionally left blank.

general soil map units

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

soil descriptions

nearly level, silty and loamy soils; on flood plains

These poorly drained to moderately well drained soils are on flood plains that are subject to flooding. They formed in alluvium. The native vegetation varies from flood-plain forest to marsh.

Only one map unit is in this group. It makes up about 3 percent of the survey area. Most areas are used for woodland and pasture, and some areas are used for cultivated crops and urban development. Major concerns of management are flooding and wetness.

1. Colo-Algansee-Minneiska

Nearly level, poorly drained to moderately well drained soils formed in loamy, silty, or sandy alluvium; on flood plains of major rivers

This map unit is on flood plains of the Minnesota and Mississippi Rivers. Few areas are more than 10 feet above the normal level of the river. Slopes range from 0 to 2 percent.

This map unit makes up about 3 percent of Dakota County. It is about 25 percent Colo soils, 14 percent Algansee soils, and 14 percent Minneiska soils. The remaining 47 percent is minor soils.

The poorly drained Colo soils are mainly on flood plains of the Mississippi River. Typically, the surface layer is mottled, very dark gray silt loam about 8 inches thick. The next layer is about 46 inches thick. It is mottled silt loam and silty clay loam that is black in the upper part and very dark gray in the lower part. The underlying material to a depth of about 60 inches is very dark gray, mottled silty clay loam.

The somewhat poorly drained Algansee soils are on the Mississippi and Minnesota River flood plains. Typically, the surface layer is very dark grayish brown sandy loam about 12 inches thick. The underlying material to a depth of 60 inches is dark brown and dark yellowish brown sand.

The moderately well drained Minneiska soils are on the Mississippi and Minnesota River flood plains. Typically, the surface layer is about 8 inches thick. It is very dark grayish brown and dark brown loam that has thin layers of silt loam and very fine sandy loam. The underlying material to a depth of about 60 inches is dark grayish brown loam and very fine sandy loam that contains strata of loamy fine sand and silt loam.

Soils of minor extent in this map unit are the Kalmarville, Lawson, Oshawa, Seelyeville, and Boots soils. The poorly drained and very poorly drained Kalmarville soils formed in stratified loamy and sandy alluvium. The somewhat poorly drained Lawson soils formed in silty clay loam alluvium. The very poorly drained Oshawa soils formed in silty loam to silty clay loam alluvium. The very poorly drained Seelyeville and Boots soils formed in organic material. All of these soils are on the flood plain and are similar in location to the Colo-Algansee-Minneiska soils.

Most of this map unit is used for woodland and pasture. Some areas are used for cultivated crops or building sites.

The suitability of these soils for cultivated crops varies. Some areas are well suited to cultivated crops if they are artificially drained. Corn and soybeans are the main crops. Other areas are poorly suited to cultivated crops because of wetness, flooding, or low available water capacity. Most of these soils have good to fair suitability for pasture; however, overgrazing can damage vegetation in sandy areas or during periods of wetness.

Because of wetness and the hazard of flooding, most areas of this map unit are generally not suitable for building sites and sanitary facilities.

level to very steep, silty, loamy, and sandy soils; on outwash plains and terraces

These well drained to excessively drained soils are on glacial outwash plains and terraces. Slopes are level to very steep. These soils formed in loamy or silty sediments that are generally underlain by sandy outwash. The native vegetation was mainly prairie.

Two map units are in this group. It makes up about 39 percent of the survey area. Most areas are used for cultivated crops, and these soils are well suited to this use. Some areas are used for urban development. Major concerns in cropland management are droughtiness and soil blowing.

2. Waukegan-Wadena-Hawick

Level to very steep, well drained and excessively drained soils formed in silty and loamy sediments over sandy outwash; on outwash plains and terraces

This map unit is on outwash plains and terraces (fig. 2) that vary 5 to 40 feet in elevation. Nearly level areas are dominant, and over half of this unit has slopes of 2 percent or less. Slopes range from 0 to 50 percent.

This map unit makes up about 36 percent of Dakota County. It is about 36 percent Waukegan soils, 22 percent Wadena soils, and 8 percent Hawick soils. The remainding 34 percent is minor soils.

The well drained Waukegan soils are on level to sloping outwash plains and terraces. Typically, the surface layer is very dark brown silt loam about 8 inches thick. The subsurface is very dark grayish brown silt loam about 5 inches thick. The subsoil is about 29 inches thick. The upper part is dark brown and dark yellowish brown silt loam. The lower part is dark yellowish brown sandy loam and gravelly coarse sand. The underlying material to a depth of about 60 inches is yellowish brown gravelly sand.

The well drained Wadena soils are on nearly level to moderately steep outwash plains and terraces. Typically, the surface layer is black, very dark brown, and dark grayish brown loam about 12 inches thick. The subsurface layer is very dark grayish brown loam about 4 inches thick. The subsoil is about 19 inches thick. The upper part is dark brown loam, and the lower part is dark yellowish brown sandy loam and loamy sand. The underlying material to a depth of about 60 inches is dark yellowish brown and brown sand. Some pedons have less than 25 percent sand in the solum.

The excessively drained Hawick soils are on sloping to very steep outwash plains and terraces. Typically, the

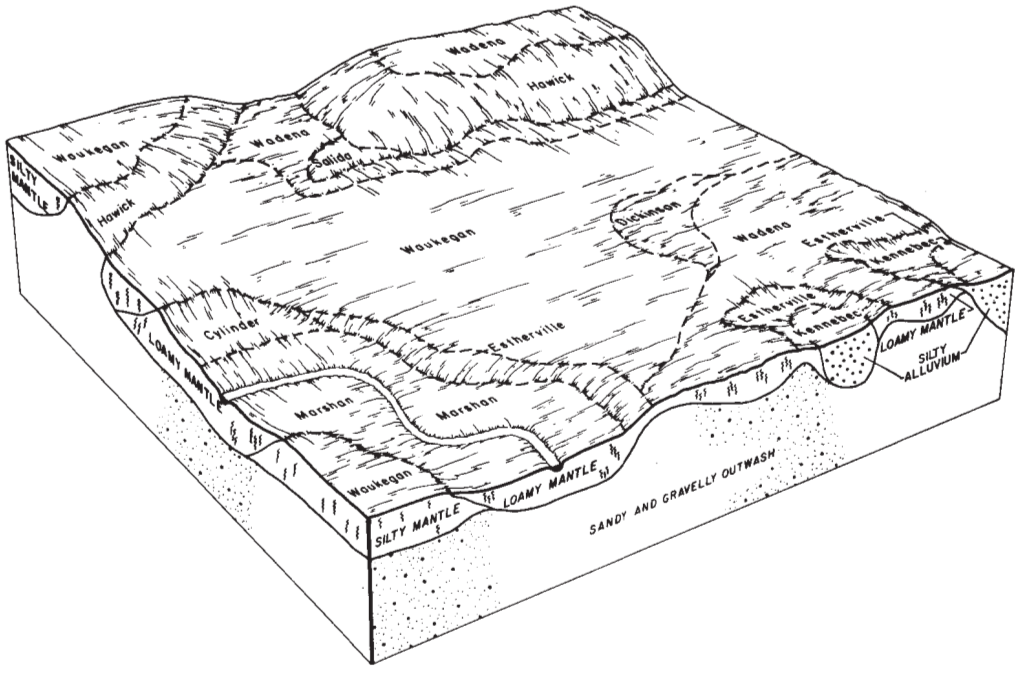


Figure 2.—Relationship of soils, underlying material, and landscape in the Waukegan-Wadena-Hawick map unit.

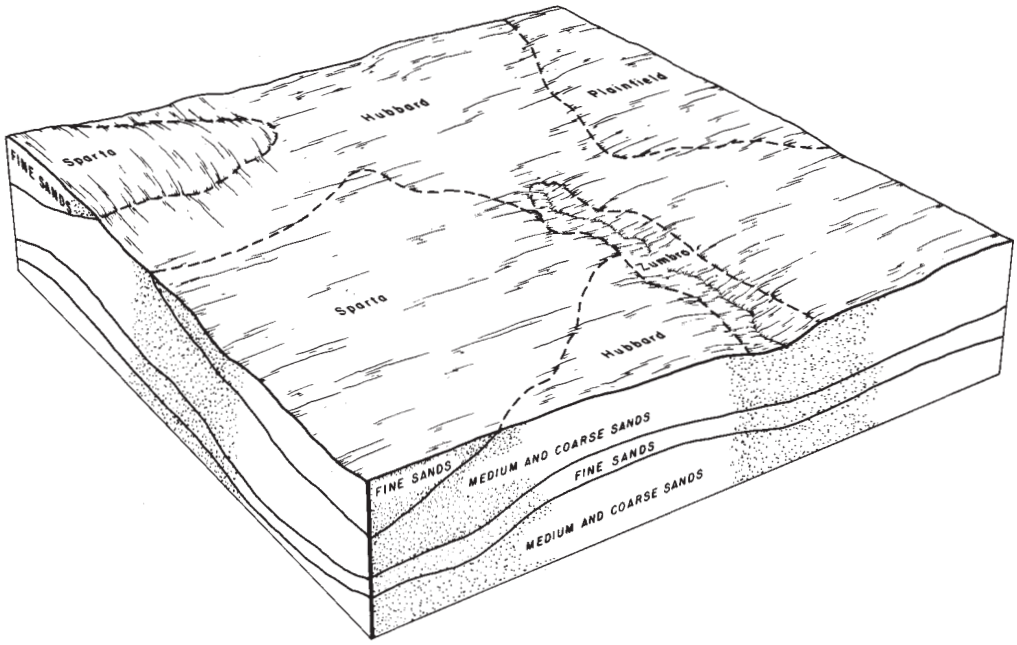


Figure 3.—Relationship of soils, underlying material, and landscape in the Hubbard-Sparta-Plainfield map unit.

surface layer is black and very dark grayish brown coarse sandy loam and gravelly loamy coarse sand about 11 inches thick. The subsoil is dark brown and dark yellowish brown gravelly loamy coarse sand and gravelly coarse sand about 10 inches thick. The underlying material to a depth of about 60 inches is yellowish brown very gravelly coarse sand.

Soils of minor extent in this map unit are the Dickinson, Estherville, Kanaranzi, Salida, Cylinder, Marshan, and Kennebec soils. The well drained Dickinson and Estherville soils and the excessively drained Kanaranzi soils are in nearly level to sloping areas. The excessively drained Salida soils are in gently sloping to sloping gravelly convex areas. The somewhat poorly drained Cylinder and the poorly drained Marshan soils are in low-lying areas in swales. The moderately well drained Kennebec soils are in depressions and drainageways.

Most of this map unit is used for cultivated crops. Some areas are used for building sites.

The soils of this unit are well suited to cultivated crops. Corn, soybeans, and small grains are the main crops. Because the available water capacity ranges from moderate to low, droughtiness limits crop growth during dry years, and early maturing crops are best suited to these soils. Irrigation is common on these soils.

This map unit is well suited to buildings but poorly suited to most sanitary facilities. Sidewall stability of excavations is poor. When these soils are used for septic tank absorption fields, there is a hazard of groundwater pollution unless specially designed systems are installed. This map unit is a good source of sand and gravel.

3. Hubbard-Sparta-Plainfield

Level to moderately steep, excessively drained soils formed in sandy sediments; on outwash plains and terraces

This map unit is on outwash plains and terraces that vary 5 to 15 feet in elevation. About one-third of this map unit has slopes of 2 percent or less (fig. 3). Slopes range from 0 to 18 percent.

This map unit makes up about 3 percent of Dakota County. It is about 36 percent Hubbard soils, 26 percent Sparta soils, and 18 percent Plainfield soils. The remaining 20 percent is minor soils.

The Hubbard soils are on level to moderately steep outwash plains. Typically, the surface layer is very dark brown loamy sand about 9 inches thick. The subsurface layer is very dark grayish brown loamy sand about 7 inches thick. The subsoil is dark brown loamy sand and sand about 22 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown sand.

The Sparta soils are on level to gently sloping outwash plains and terraces. Typically, the surface and subsurface layers are very dark grayish brown and dark brown loamy fine sand about 10 inches thick. The subsoil is dark yellowish brown loamy fine sand and fine sand about 15 inches thick. The underlying material to a depth of about 60 inches is yellowish brown fine sand.

The Plainfield soils are on nearly level to moderately steep outwash plains and terraces. Typically, the surface layer is very dark brown loamy sand about 4 inches thick. The subsoil is dark yellowish brown and yellowish brown sand about 24 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, brownish yellow, and light yellowish brown sand.

Soils of minor extent in the map unit are the Dickinson, Gotham, and Zumbro soils. The well drained and somewhat excessively drained Dickinson soils and the somewhat excessively drained Gotham soils are on adjacent outwash plains and terraces. The Dickinson soils have less sand in the upper layer, and the Gotham soils have bands that contain more clay in the subsoil. The well to moderately well drained Zumbro soils are in drainageways.

Most of this map unit is used for cultivated crops. Corn and small grains are the main crops.

The soils of this map unit are poorly suited to most crops because of the low available water capacity. Early maturing or drought-resistant crops are best suited to these soils. Most of these soils are well suited to irrigation; however, frequent applications are needed because of their low available water capacity and rapid permeability. Mulch tillage and other conservation tillage practices help conserve moisture and control soil blowing.

This map unit is well suited to buildings but poorly suited to most sanitary facilities. When these soils are used for sanitary facilities, there is a hazard of ground-water pollution. Sidewall stability of excavations is poor. This map unit is a good source of sand and gravel.

nearly level, silty and loamy soils; on outwash plains and terraces

These somewhat poorly drained and poorly drained soils are on glacial outwash plains. They are nearly level. These soils formed in silty or loamy sediment that is generally underlain by sandy outwash. The native vegetation was mainly prairie.

Only one map unit is in this group. It makes up about 7 percent of the survey area. Most areas of this map unit are used for cultivated crops, but some are in permanent pasture. Wetness is the main management concern.

4. Marshan-Cylinder

Nearly level, poorly drained and somewhat poorly drained soils formed in silty and loamy sediments over sandy outwash; on outwash plains and terraces

This map unit is on outwash plains and terraces that vary 5 to 10 feet in elevation. Slopes are 2 percent or less in most areas. Most areas are artificially drained.

This map unit makes up about 7 percent of Dakota County. It is about 30 percent Marshan soils and 28 percent Cylinder soils. The remaining 42 percent is minor soils.

The somewhat poorly drained Cylinder soils are on nearly level outwash plains and terraces. Typically, the surface layer is black and very dark grayish brown loam about 12 inches thick. The subsoil is dark brown loam and loamy sand about 16 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown sand.

The poorly drained Marshan soils are on nearly level outwash plains and terraces. Typically, the surface layer is black silty clay loam and loam about 14 inches thick. The subsoil is mottled, dark gray, grayish brown, and olive gray loam about 18 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown and grayish brown sand.

Soils of minor extent in this map unit are the Cordova, Kato, Mayer, Seelyeville, Wadena, and Waukegan soils. The poorly drained Cordova soils are on nearly level, low lying moraines and have a loamy subsoil. The poorly drained Kato soils are on nearly level outwash plains and have more silt in the upper mantle. The poorly drained Mayer soils are on nearly level or concave outwash plains and are calcareous throughout. The very poorly drained Seelyeville soils are in depressions on outwash plains. They formed in organic material. The well drained Wadena and Waukegan soils are in level to moderately steep areas.

Most of this map unit is used for cultivated crops. Some areas are in permanent pasture. Corn and soybeans are the main crops.

Most soils of this unit are well suited to crops if properly drained. Wetness and a seasonal high water table may restrict root growth, cause the soil to warm slowly in the spring, and limit fieldwork. Most areas are well suited to pasture and hay; however, grazing when the soil is too wet will cause compaction and clodding.

Most of this map unit is poorly suited to buildings and sanitary facilities because of the high water table. Septic tank absorption fields may function poorly and pollute ground water, unless specially designed systems are installed.

nearly level to steep, loamy and silty soils; on uplands

These somewhat excessively drained to poorly drained soils are on glacial moraines, till plains, and loess-mantled uplands. Slopes are nearly level to steep. They formed in medium textured material. The native vegetation varies from prairie to mixed hardwood forest.

Four map units are in this group. It makes up about 23 percent of the survey area. Most areas are used for cultivated crops, and these soils are well suited to this use. The major management concerns are the hazards of erosion and droughtiness.

5. Lester-Blooming-Merton

Gently sloping to moderately steep, well drained to somewhat poorly drained soils formed in loamy and silty sediments and loamy glacial till; on uplands

This map unit is on glacial end moraines that vary 20 to 45 feet in elevation. The drainage pattern is poorly developed, and the more poorly drained areas often are irregular in shape (fig. 4). Slopes are generally short and uneven. They range from 1 to 18 percent.

This map unit makes up about 8 percent of Dakota County. It is about 24 percent Lester soils, 14 percent Blooming soils, and 12 percent Merton soils. The remaining 50 percent is minor soils.

The well drained Lester soils are on gently sloping to moderately steep side slopes and hill crests. Typically, the surface layer is very dark brown loam about 6 inches thick. The subsoil is about 32 inches thick. It is dark brown loam and clay loam in the upper part and brown loam in the lower part. The underlying material to a depth of about 60 inches is light yellowish brown and light olive brown, calcareous loam.

The well drained Blooming soils are on gently sloping side slopes and hill crests. Typically, the surface layer is very dark brown silt loam about 9 inches thick. The subsoil is about 39 inches thick. It is dark brown silty clay loam that grades to dark yellowish brown and yellowish brown sandy clay loam in the lower part. The underlying material to a depth of about 60 inches is light olive brown, calcareous fine sandy loam.

The moderately well drained to somewhat poorly drained Merton soils are on gently sloping end moraines. Typically, the surface layer is black silt loam about 9 inches thick. The subsurface layer is very dark brown silt loam about 6 inches thick. The subsoil is about 35 inches thick. The upper part is dark grayish brown loam; the middle part is mottled, dark grayish brown loam; and the lower part is mottled, light olive brown loam. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam.

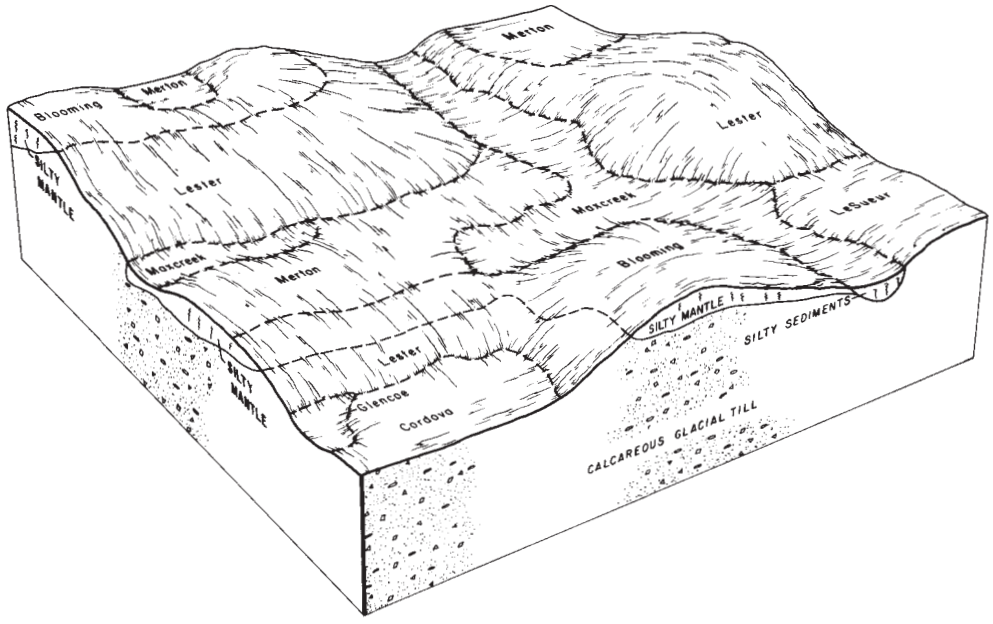


Figure 4.—Relationship of soils, underlying material, and landscape in the Lester-Blooming-Merton map unit.

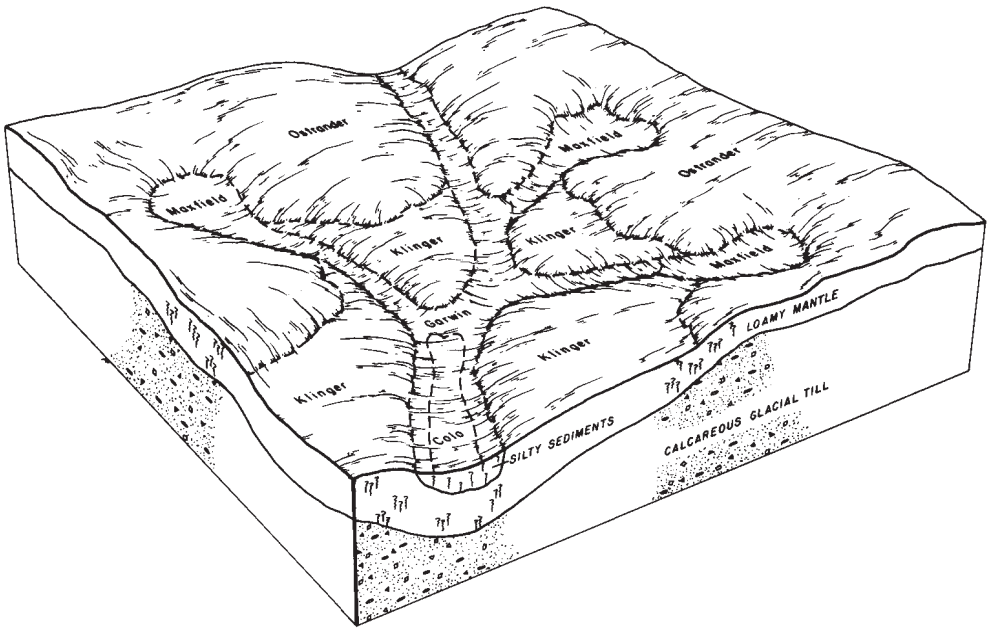


Figure 5.—Relationship of soils, underlying material, and landscape in the Ostrander-Klinger-Maxfield map unit.

Soils of minor extent in this map unit are the Kingsley, Le Sueur, Cordova, Garwin, Maxcreek, Webster, and Glencoe soils. The well drained Kingsley soils are on gently sloping to very steep side slopes and hill crests. The moderately well to somewhat poorly drained Le Sueur soils are on lower side slopes. The poorly drained Cordova, Garwin, and Maxcreek soils are in slight depressions and swales and in the heads of drainageways. The poorly drained Webster soils and the very poorly drained Glencoe soils are in depressions.

Most of this map unit is used for cultivated crops. Corn, soybeans, and hay are the main crops. Some areas are used for woodland pasture.

Most soils of this unit are well suited to crops. Minimum tillage or contour farming reduces erosion in gently sloping to sloping areas. These soils are also well suited to pasture. Proper stocking and restricted use of pasture during wet periods reduce surface compaction and help to maintain good grazing conditions.

The Blooming and Lester soils are fairly suited to buildings and to most sanitary facilities. Frost action and shrink-swell potential limit the use of these soils for buildings and roads. Septic tank absorption fields may not function properly because these soils are moderately permeable. Wetness and frost action are limitations for the use of the Merton soils for buildings. Merton soils are poorly suited to most sanitary facilities because of the high water table.

6. Ostrander-Klinger-Maxfield

Nearly level to sloping, well drained, somewhat poorly drained, and poorly drained soils formed in silty and loamy sediments and loamy glacial till; on uplands

This map unit is on glacial till plains that vary 10 to 100 feet in elevation. A well-formed drainage system dissects the landscape (fig. 5). Slopes are often 2,000 feet or more long. They range from 0 to 12 percent.

This map unit makes up about 6 percent of Dakota County. It is about 52 percent Ostrander soils, 22 percent Klinger soils, and 15 percent Maxfield soils. The remaining 11 percent is minor soils.

The well drained Ostrander soils are on side slopes and hill crests. Typically, the surface layer is black loam about 13 inches thick. The subsurface layer is very dark grayish brown loam about 4 inches thick. The subsoil is yellowish brown loam about 36 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous loam.

The somewhat poorly drained Klinger soils are gently sloping. Typically, the surface layer is black and very dark grayish brown silt loam about 13 inches thick. The subsoil is about 42 inches thick. The upper part is a mantle of dark grayish brown silt loam grading to dark brown loam high in silt. The lower part is yellowish brown grading to grayish brown mottled loam. The underlying

material to a depth of about 60 inches is grayish brown, mottled, calcareous loam.

The poorly drained Maxfield soils are in the head of upland drainageways. Typically, the surface layer is black silty clay loam about 15 inches thick. The subsurface layer is very dark gray silty clay loam about 6 inches thick. The subsoil extends to a depth of 42 inches. The upper part is grayish brown, mottled silty clay loam, and the lower part is yellowish brown, mottled loam. The underlying material to a depth of about 60 inches is yellowish brown, mottled loam.

Soils of minor extent in this map unit are the Garwin, Colo, Dickinson, Port Byron, Etter, and Rockton soils. The poorly drained Garwin soils are in slight depressions and are silty throughout. The poorly drained Colo soils are in drainageways and are subject to flooding. The well drained to somewhat excessively drained Dickinson soils and the well drained Port Byron soils are on side slopes. The Dickinson soils have a sandy subsoil. The Port Byron soils are silty throughout. The well drained Etter and Rockton soils are on side slopes where bedrock is nearer to the surface.

Most of this map unit is used for cultivated crops. Corn, soybeans, and small grains are the main crops. A few areas are used for pasture.

Most soils of this unit are well suited to cultivated crops. Minimum tillage and contour farming control erosion on the gently sloping to sloping Klinger and Ostrander soils. Artificial drainage improves crop yields and soil conditions on the Maxfield soils. These soils are well suited to pasture or hay. Overgrazing or grazing when the soil is wet causes surface compaction, especially on the Maxfield soils.

The Ostrander and Klinger soils are fairly suited to buildings. Wetness is the major limitation. The high water table in the Maxfield soils severely limits their use for buildings. Septic tank absorption fields may not function properly because of the high water table in the soils of this map unit.

7. Ostrander-Carmi-Burkhardt

Gently sloping to moderately steep, well drained and somewhat excessively drained soils formed in loamy sediments and in the underlying loamy or sandy glacial drift; on uplands

This map unit is in areas of glacial drift on uplands that vary 20 to 100 feet in elevation. A well-formed drainage system dissects the landscape (fig. 6). Slopes range from 1 to 18 percent.

This map unit covers about 6 percent of Dakota County. It is about 24 percent Ostrander soils, 14

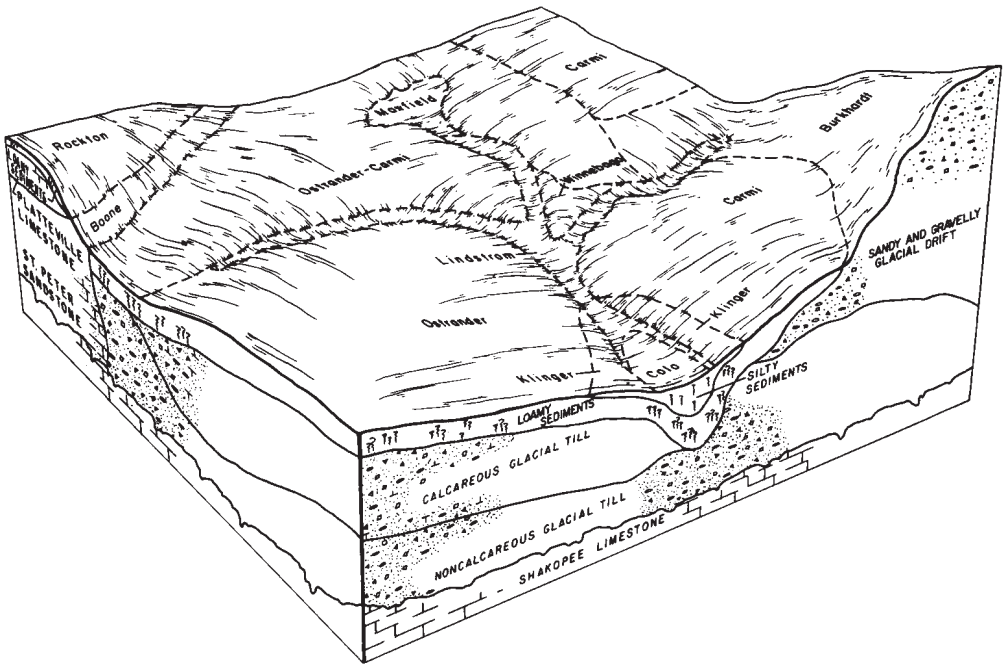


Figure 6.—Relationship of soils, underlying material, and landscape in the Ostrander-Carmi-Burkhardt map unit.

percent Carmi soils, and 12 percent Burkhardt soils. The remaining 50 percent is minor soils.

The well drained Ostrander soils are on gently sloping to sloping side slopes and hill crests. Typically, the surface layer is black loam about 13 inches thick. The subsurface layer is very dark grayish brown loam about 4 inches thick. The subsoil is yellowish brown loam about 36 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous loam.

The well drained Carmi soils are on gently sloping side slopes and hill crests. Typically, the surface layer is black and very dark grayish brown loam about 13 inches thick. The subsoil is about 35 inches thick. The upper part is dark yellowish brown loam and dark brown sandy loam. The lower part is strong brown loamy sand and dark brown gravelly sandy loam. The underlying material to a depth of about 60 inches is yellowish red gravelly loamy sand.

The somewhat excessively drained Burkhardt soils are on sloping to moderately steep knolls and side slopes on uplands. Typically, the surface and subsurface layers are very dark brown and dark brown sandy loam about 12 inches thick. The subsoil is dark reddish brown sandy loam and gravelly sandy loam about 10 inches thick. The underlying material to a depth of about 60 inches is multicolored gravelly coarse sand.

Soils of minor extent in this map unit are the Lindstrom, Boone, Etter, Dickinson, Winnebago, Maxfield, Klinger, Wadena, and Waukegan soils. The well drained Lindstrom soils are silty throughout and are in drainageways. The excessively drained Boone and well drained Etter soils are gently sloping to very steep, and sandstone bedrock is close to the surface. The well drained to somewhat excessively drained Dickinson soils are on side slopes. The well drained Winnebago soils are on gently sloping side slopes. The poorly drained Maxfield and somewhat poorly drained Klinger soils are in heads of drainageways and on foot slopes. The well drained Wadena and Waukegan soils are level to moderately steep.

Most of this map unit is used for cultivated crops or pasture. Corn, soybeans, and small grains are the main crops.

The Ostrander and Carmi soils are well suited to most cultivated crops. Minimum tillage and contour farming reduce runoff and erosion on these soils. The Burkhardt soils are poorly suited to most crops because of their low available water capacity. They are best suited to early maturing crops. They are suited to irrigation; however, frequent applications are needed because of the low available water capacity.

The Ostrander and Carmi soils are well suited to pasture, and the Burkhardt soils are fairly suited to this use. Because of the low available water capacity of the Burkhardt soil, forage yields are low during dry periods.

Most of this map unit is well suited to buildings but poorly suited to most sanitary facilities. Septic tank absorption fields need to be specially designed to prevent ground-water pollution on the Carmi or Burkhardt soils.

8. Tallula-Port Byron-Bold

Nearly level to steep, well drained soils formed in loess; on uplands

This map unit is on silt-mantled uplands that vary 20 to 60 feet in elevation in the gently sloping areas and as much as 200 feet along a few deep stream valleys. Slopes are commonly long and uniform. A well-developed drainage system dissects the landscape (fig. 7).

This map unit makes up about 3 percent of Dakota County. It is about 38 percent Tallula soils, about 18 percent Port Byron soils, and about 18 percent Bold soils. The remaining 26 percent is minor soils.

The well drained Tallula soils are on gently sloping to sloping side slopes and hill crests. Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick. The subsoil is yellowish brown silt loam about 18 inches thick. The underlying material to a depth of about 60 inches is yellowish brown calcareous silt loam.

The well drained Port Byron soils are on nearly level to sloping side slopes and hill crests. Typically, the surface layer is black silt loam about 14 inches thick. The subsurface layer is very dark grayish brown silt loam about 5 inches thick. The subsoil is dark yellowish brown silt loam about 33 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown silt loam.

The well drained Bold soils are on sloping to steep side slopes. These soils are mapped only in complex with the Timula soils. Typically, the surface layer of the Bold soils is yellowish brown silt loam about 8 inches thick. The underlying material to a depth of 60 inches is yellowish brown, calcareous silt loam.

Soils of minor extent in this map unit are the Frontenac, Garwin, Joy, and Lindstrom soils. The well drained Frontenac soils are on very steep side slopes of deep valleys. The poorly drained Garwin soils are along planned drainageways. The somewhat poorly drained Joy soils are in gently sloping to slightly concave areas on uplands. The well drained Lindstrom soils are in the heads of drainageways and on foot slopes. They have thick, dark-colored surface and subsurface layers.

Most of this map unit is used for cultivated crops. Corn and soybeans are the main crops. Some areas are in pasture.

Most soils of this unit are well suited to cultivated crops, except for the moderately steep to very steep soils that are easily eroded. Minimum tillage, contour farming, and including cover crops in the cropping system reduce erosion and runoff. These soils are well suited to pasture. Proper stocking and timely deferment of grazing help maintain the pasture and reduce erosion.

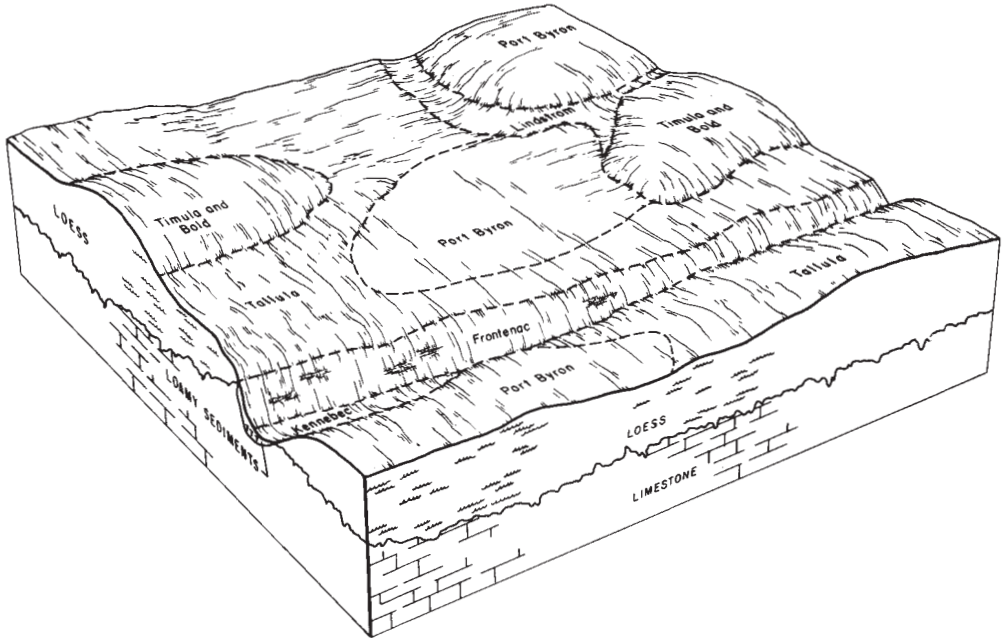


Figure 7.—Relationship of soils, underlying material, and landscape in the Tallula-Port Byron-Bold map unit.

The nearly level to gently sloping soils of this map unit are well suited to buildings and to most sanitary facilities. In sloping to very steep areas careful planning or extensive landscaping may be needed. Unless carefully controlled, erosion from construction sites may be severe. Side slope seepage of effluent in the steeper areas is a hazard if these soils are used for septic tank absorption fields.

nearly level to sloping, loamy soils that are underlain by bedrock; on uplands and terraces

These well drained soils are on bedrock ridges, terraces, and escarpments. They are nearly level to sloping. These soils formed in shallow to moderately deep loamy sediments underlain by limestone or sandstone bedrock. The native vegetation was prairie or oak forest.

Only one map unit is in this group. It makes up about 9 percent of the survey area. Most areas are used for cultivated crops or pasture, and they are fairly suited to these uses. Some steep areas remain under native vegetation. The main management concerns are droughtiness and the hazard of erosion.

9. Etter-Rockton-Copaston

Nearly level to sloping, well drained soils formed in loamy sediments over sandstone or limestone bedrock; on uplands and terraces

This map unit is mainly on bedrock uplands and terraces that vary as much as 100 feet in elevation (fig. 8). A few minor soils in deep stream valleys have steep slopes. Many slopes are 1,000 feet or more long. A well-formed dendritic drainage system dissects the landscape. Slopes range from 0 to 12 percent.

This map unit makes up about 9 percent of Dakota County. It is about 20 percent Etter soils, 18 percent Rockton soils, and 12 percent Copaston soils. The remaining 50 percent is minor soils.

The well drained Etter soils are on gently sloping to sloping uplands. Typically, the surface layer is very dark grayish brown fine sandy loam about 15 inches thick. The subsoil is dark brown fine sandy loam about 6 inches thick. The underlying material to a depth of about 60 inches is brownish yellow and yellow fine sand.

The well drained Rockton soils are on nearly level terraces and gently sloping to sloping side slopes on uplands. Typically, the surface layer is black and very dark grayish brown loam about 16 inches thick. The

subsoil is dark brown clay loam about 19 inches thick. The soil is underlain by limestone bedrock.

The well drained Copaston soils are on nearly level terraces and gently sloping to sloping side slopes. Typically, the surface layer is very dark brown loam about 6 inches thick. The subsoil is dark brown and dark yellowish brown loam about 9 inches thick. The soil profile is underlain by limestone bedrock.

Soils of minor extent in this map unit are the Boone, Sparta, Frontenac, Marlean, Brodale, Carmi, Ostrander, and Terril soils. The excessively drained Boone and Sparta bedrock substratum soils are on gently sloping to very steep side slopes and hill crests. The well drained Frontenac and Marlean soils and the excessively drained Brodale soils are on steep to very steep side slopes. The well drained Carmi and Ostrander soils are on gently sloping to sloping side slopes and hill crests where bedrock is deep. The moderately well drained Terril soils are on foot slopes and in heads of drainageways. They are deep to bedrock.

Most of this map unit is used for cultivated crops or pasture. Corn, soybeans, small grains, and hay are the main crops. Some steep areas are in woodland or native prairie grasses.

Most soils of this map unit are fairly suited to cultivated crops. Because droughtiness limits crop growth during dry seasons, early maturing crops are best suited. These soils can be irrigated, but their moderately rapid permeability makes frequent applications necessary. Keeping tillage to a minimum, maintaining a good cover crop, and returning crop residues to the soil help conserve moisture and control erosion. These soils have fair suitability for use as pasture. Droughtiness limits forage growth during dry seasons.

This map unit is fairly to poorly suited to buildings and is poorly suited to most sanitary facilities. Excavation for foundations and basements is difficult because bedrock is shallow to moderately deep in most areas. Septic tank absorption systems may cause ground-water pollution.

gently sloping to very steep, loamy and sandy soils; on uplands and pitted outwash plains

These well drained to excessively drained soils are on end moraines. They are sloping to very steep. These soils formed in medium to coarse textured glacial sediments. The native vegetation was mainly deciduous hardwood forest.

Only one map unit is in this group. It makes up about 19 percent of the survey area. Most of this unit is used for residential development. Some areas are idle, in unmanaged woodland, or in pasture or crops.

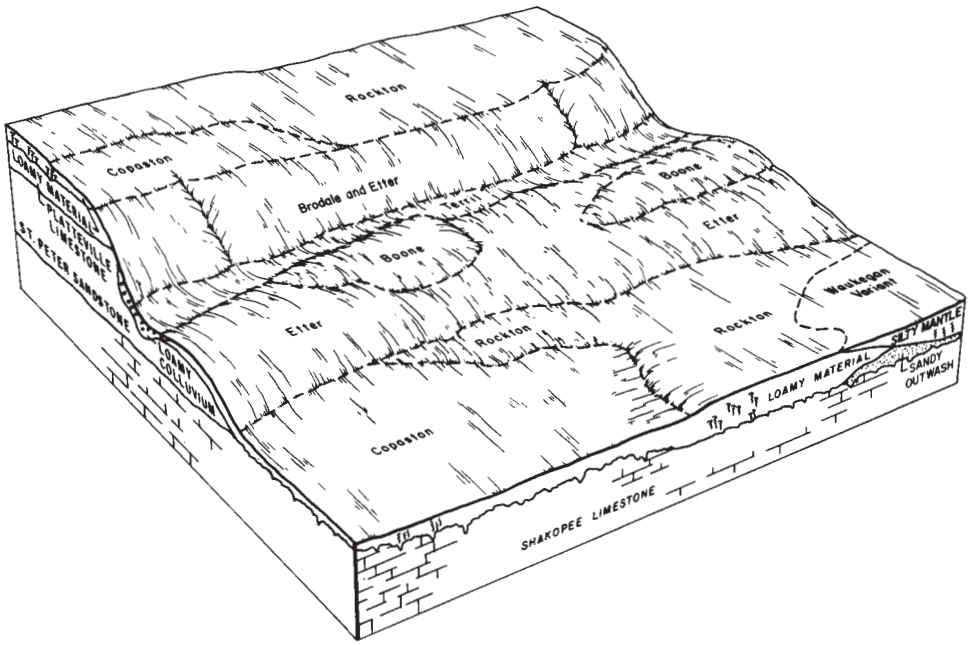


Figure 8.—Relationship of soils, underlying material, and landscape in the Etter-Rockton-Copaston map unit.

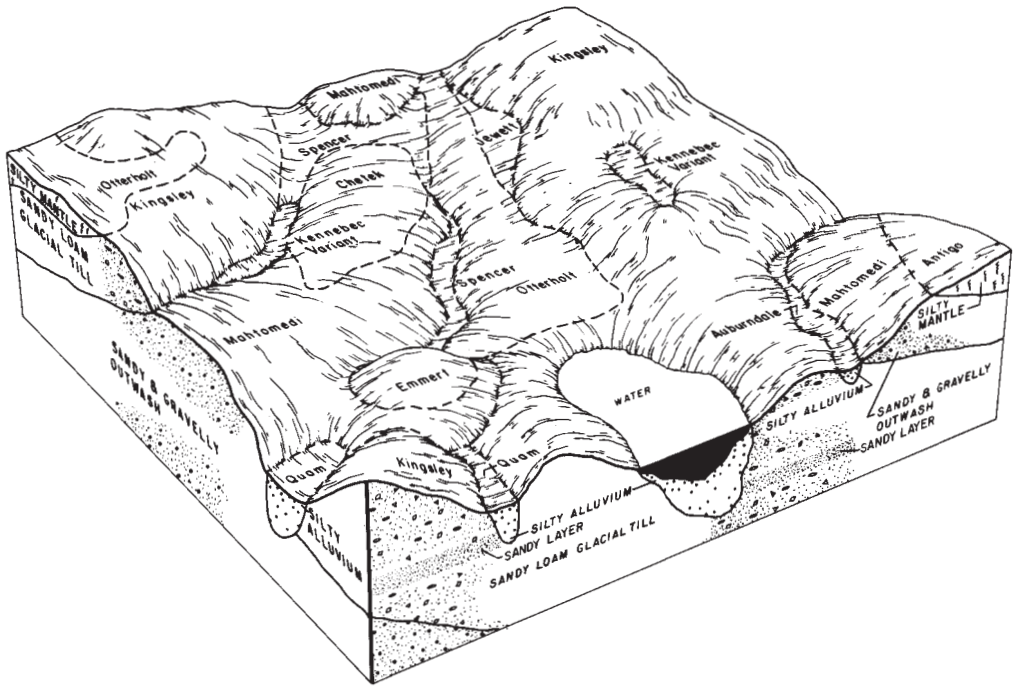


Figure 9.—Relationship of soils, underlying material, and landscape in the Kingsley-Mahtomedi map unit.

10. Kingsley-Mahtomedi

Gently sloping to very steep, well drained and excessively drained soils formed in loamy and sandy glacial till and sandy glacial outwash; on uplands and pitted outwash plains

This map unit is on a complex landscape of end moraines and pitted outwash plains that vary 50 to 120 feet in elevation. Surface drainage is poorly developed in this unit; most runoff collects in closed depressions. Slopes are often short and irregular in shape. They range from 3 to 40 percent.

This map unit makes up about 19 percent of Dakota County. It is about 40 percent Kingsley soils and 12 percent Mahtomedi soils (fig. 9). The remaining 48 percent is minor soils. The area is complex, and the soils are frequently so intermingled that it was not practical to map them separately.

The well drained Kingsley soils have undulating to very steep slopes. Typically, the surface layer is black sandy loam about 8 inches thick. The subsurface layer is brown loamy sand about 4 inches thick. The subsoil is 26 inches thick. The upper part is dark brown and reddish brown sandy loam. The lower part is dark brown sandy loam. The underlying material to a depth of about 60 inches is dark brown sandy loam with layers of loamy sand.

The excessively drained Mahtomedi soils have undulating to very steep slopes. Typically, the surface layer is very dark grayish brown loamy sand about 5 inches thick. The subsoil is dark brown and dark yellowish brown gravelly coarse sand and coarse sand about 30 inches thick. The underlying material to a depth of about 60 inches is yellowish brown stratified sand and gravelly coarse sand.

The large number of minor soils in this map unit range from very poorly drained to excessively drained and from depressional to very steep. The Antigo, Crystal Lake, Emmert, Otterholt, Spencer, and Wadena soils are moderately well drained to excessively drained and are in nearly level to rolling areas. The Chetek, Lester, and Plainfield soils are well drained to excessively drained and are in sloping to very steep areas. The Auburndale, Kennebec, Palms, Quam, and Seelyeville soils are moderately well drained to very poorly drained and are in depressions.

Most of this map unit is used for residential development or woodland. A few areas are used for cultivated crops or pasture.

The soils of this map unit are poorly suited to most cultivated crops. Erosion and complex slopes are the main management concerns. Erosion can be controlled by using minimum tillage or by including hay crops in the

rotation. Droughtiness limits crop growth during dry years. Stoniness may hinder the use of equipment. Most areas of this map unit are well suited to pasture; however, droughtiness may limit forage growth during dry seasons.

Most of this map unit is poorly suited to buildings. Because of the nature of the slopes, erosion of construction sites is severe unless controlled by careful planning or landscaping. Septic tank absorption fields may not function properly because some soils in the map unit have moderately slow permeability. There is also the hazard of sidehill seepage of effluent in the steeper 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, Lester loam, 6 to 12 percent slopes, is one of several phases in the Lester series.

Some map units are made up of two or more major soils. These map units are called soil complexes, soil associations, or undifferentiated groups.

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. Kingsley-Mahtomedi-Spencer complex, 3 to 8 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in a mapped area are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Aquolls and Histosols, ponded, is an undifferentiated group in this survey area.

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

2B—Ostrander loam, 1 to 6 percent slopes. This gently sloping, well drained soil is on crests and convex side slopes of uplands. Individual areas are irregular in shape and range from about 15 to 90 acres.

Typically, the surface layer is black loam about 13 inches thick. The subsurface layer is very dark grayish brown loam about 4 inches thick. The subsoil is yellowish brown loam about 36 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous loam. Some areas have a strong brown subsoil and substratum. Also, in some areas soft sandstone bedrock is at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of the Dickinson and Klinger soils. The Dickinson soil is sandier throughout and is similar in position to the Ostrander soil. The Klinger soil is somewhat poorly drained and is in swales. These soils make up 2 to 10 percent of the map unit.

This Ostrander soil is moderately permeable. The available water capacity is high, and runoff is medium.

The reaction of the subsoil is strongly acid to neutral. The organic matter content is moderate.

Most areas of this Ostrander soil are cropland and are well suited to this use. Corn and soybeans are the main crops. Controlling erosion on the steeper, longer slopes is the main concern of management. Keeping tillage to a minimum, stubble mulching, and returning crop residues to the soil increase organic matter content and water infiltration and reduce runoff and erosion.

This soil is well suited to pasture and hay. Proper stocking, rotation grazing, fertilizing, and controlling weeds help keep the pasture and soil in good condition. Also, including legume and grass forage in the cropping system reduces erosion.

This soil is suitable for buildings. Constructing roads on well-compacted, coarse textured base material helps protect them from frost damage. This soil is suitable for septic tank absorption fields.

This Ostrander soil is in capability subclass IIe.

2C—Ostrander loam, 6 to 12 percent slopes. This sloping, well drained soil is on crests and convex side slopes of uplands. Individual areas are irregular in shape and range from about 10 to 45 acres.

Typically, the surface layer is black loam about 13 inches thick. The subsurface layer is very dark grayish brown loam about 4 inches thick. The subsoil is yellowish brown loam about 36 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous loam. Some areas have strong brown subsoil and substratum colors. Also, in some areas soft sandstone bedrock is at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of the Dickinson and Klinger soils. The Dickinson soil is sandier throughout and is similar in position to the Ostrander soil. The Klinger soil is somewhat poorly drained and is in swales. These soils make up 2 to 8 percent of the map unit.

This Ostrander soil is moderately permeable. The available water capacity is high, and runoff is rapid. The reaction of the subsoil is strongly acid to neutral. The organic matter content is moderate.

Most areas of this Ostrander soil are cropland and are well suited to this use. Corn and soybeans are the main crops. Controlling erosion is the main concern of management. Keeping tillage to a minimum, stubble mulching, farming on the contour, terracing, and returning crop residues to the soil increase organic matter content and water infiltration and reduce runoff and erosion. Grassed waterways are needed in some areas to prevent gullying.

This soil is well suited to pasture and hay. Proper stocking, rotation grazing, fertilizing, and controlling weeds help keep the pasture and soil in good condition. Also, including legume and grass forage in the cropping system reduces erosion.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. Using well-compacted, coarse textured base material helps protect them from frost damage. Land shaping and installing the distribution lines across the slope are generally necessary for the proper operation of septic tank absorption fields.

This Ostrander soil is in capability subclass IIIe.

7A—Hubbard loamy sand, 0 to 1 percent slopes. This level, excessively drained soil is on outwash plains. Individual areas are irregular in shape and range from about 3 to 50 acres.

Typically, the surface layer is very dark brown loamy sand about 10 inches thick. The subsurface layer is very dark grayish brown loamy sand about 7 inches thick. The subsoil is dark brown loamy sand and sand about 22 inches thick. The underlying material to a depth of 60 inches is dark yellowish brown sand. Free carbonates are in some areas, and the sand is finer textured or the surface soil is more than 22 inches thick or less than 10 inches thick.

Included with this soil in mapping are small areas of the Dickinson soil. It has a finer textured solum and is in slight depressions. This soil makes up 5 to 10 percent of the map unit.

Permeability of this Hubbard soil is rapid, and the available water capacity is low. Surface runoff is very slow. Reaction in the subsoil ranges from strongly acid to neutral. Organic matter content is moderate.

Most areas of this Hubbard soil are cropland. Corn and small grains are the main crops. This soil is poorly suited to crops because it has low available water capacity and is subject to late-season drought. Early maturing crops are best suited. Soil blowing is a hazard and may damage young plants. Using minimum tillage, no-till planting, cover crops, and field windbreaks reduces soil blowing and conserves moisture. This Hubbard soil is well suited to irrigation; however, frequent applications are needed because of its low available water capacity and rapid permeability.

This soil is fairly suited to pasture and hay. It provides fair pasture in the spring, but during the drier summer supplemental pastures may be needed to insure adequate production. Proper stocking, weed control, pasture rotation, and timely deferment of grazing help to maintain a good cover of the more desirable grasses. Where planting is necessary to improve stands, more drought-resistant plants are needed.

This soil is fairly suited to woodland. Seedling mortality is a problem because of the low available water capacity, and drought-tolerant trees should be selected.

This soil is suitable for buildings and local roads. It readily absorbs but does not adequately filter the effluent

from septic tank absorption fields. The poor filtering capacity of this Hubbard soil may result in the pollution of ground-water supplies, but these limitations can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Hubbard soil is in capability subclass IVs.

7B—Hubbard loamy sand, 1 to 6 percent slopes. This gently sloping, excessively drained soil is on outwash plains. Individual areas are irregular in shape and range from about 3 to 35 acres.

Typically, the surface layer is very dark brown loamy sand about 9 inches thick. The subsurface layer is very dark grayish brown loamy sand about 7 inches thick. The subsoil is dark brown loamy sand and sand about 22 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown sand. Free carbonates are in some areas, the sand is finer textured, or the surface soil is more than 22 inches thick or less than 10 inches thick.

Included with this soil in mapping are small areas of the Dickinson soil. It has a finer textured solum and is in slight depressions. This soil makes up 5 to 10 percent of the map unit.

Permeability of this Hubbard soil is rapid, and the available water capacity is low. Surface runoff is slow. Reaction in the subsoil ranges from strongly acid to neutral. Organic matter content is moderate.

Most areas of this Hubbard soil are cropland. Corn and small grains are the main crops. This soil is poorly suited to crops commonly grown in the area because it has low available water capacity and is subject to late-season drought. Early maturing crops are best suited to this soil. There is a slight hazard of erosion on the steeper slopes. Soil blowing is a hazard, and young plants are easily damaged by blowing sand. Minimum tillage, no-till planting, cover crops, and field windbreaks reduce soil blowing and erosion and conserve moisture. This Hubbard soil is well suited to irrigation; however, frequent applications are needed because the available water capacity is low and permeability is rapid.

This soil is fairly suited to pasture and hay. It provides fair pasture in spring, but supplemental pastures may be needed during the summer to insure adequate production. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain a good cover of the more desirable grasses and reduce erosion. Where planting is necessary to improve stands, more drought-resistant plants are needed.

This soil has fair suitability for woodland. Seedling mortality is severe because the available water capacity is low, and drought-tolerant trees should be selected.

This soil is suitable for buildings and local roads. It readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity of this Hubbard soil may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Hubbard soil is in capability subclass IVs.

7C—Hubbard loamy sand, 6 to 12 percent slopes. This sloping, excessively drained soil is on outwash plains. Individual areas are irregular in shape and range from about 3 to 25 acres.

Typically, the surface layer is very dark brown loamy sand about 8 inches thick. The subsurface layer is very dark grayish brown loamy sand about 5 inches thick. The subsoil is dark brown loamy sand and sand about 18 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown sand. Free carbonates are in some areas, the sand is finer textured, or the surface soil is less than 10 inches thick.

Included with this soil in mapping are small areas of the Dickinson soil. It has a finer textured solum and is in slight depressions. This soil makes up 5 to 10 percent of the map unit.

Permeability of this Hubbard soil is rapid, and the available water capacity is low. Surface runoff is medium. Reaction in the subsoil ranges from strongly acid to neutral. Organic matter content is moderate.

Most areas of this Hubbard soil are cropland. Corn and small grains are the main crops. This soil is generally not suited to cultivated crops because the available water capacity is low and the hazard of erosion is severe. If this soil is used for crops, costly and intensive erosion control is needed to keep soil loss within acceptable limits. Some areas of this Hubbard soil are irrigated; however, frequent applications are needed because it has very low available water capacity and rapid permeability.

This soil is fairly suited to pasture and hay. It provides fair pasture in the spring and fall, but during the summer supplemental pastures may be needed to insure adequate production. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain a good cover of the more desirable grasses and reduce erosion. Where replanting is necessary, more drought-resistant plants are needed. Keeping these areas under continuous cover reduces erosion.

This soil has fair suitability for woodland. Seedling mortality is severe because the available water capacity is low, and drought-tolerant trees should be selected.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this

limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Hubbard soil is in capability subclass VIs.

7D—Hubbard loamy sand, 12 to 18 percent slopes. This moderately steep, excessively drained soil is on side slopes on outwash plains. Individual areas are elongated and range from about 5 to 30 acres.

Typically, the surface layer is very dark brown loamy sand about 7 inches thick. The subsurface layer is very dark grayish brown loamy sand about 4 inches thick. The subsoil is dark brown loamy sand about 17 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown sand. Free carbonates are in some areas, the sand is finer textured, or the surface soil is less than 10 inches thick.

Included with this soil in mapping are small areas of the Hawick soil. It contains more coarse fragments and is more alkaline. This Hawick soil is similar in position to the Hubbard soil and makes up to 10 percent of the map unit.

Permeability of this Hubbard soil is rapid, and the available water capacity is low. Surface runoff is rapid. Reaction in the subsoil ranges from strongly acid to neutral. Organic matter content is moderate.

Most areas of this Hubbard soil are used for pasture and hay. This soil is fairly suited to this use. It provides fair pasture in the spring and fall, but during the drier summer months supplemental pastures may be needed to insure adequate production. Proper stocking, rotation grazing, and timely deferment of grazing help to maintain a good cover of the more desirable grasses and reduce erosion. Where replanting is necessary, more drought-resistant plants are needed. Keeping these areas under continuous cover reduces erosion.

This soil is not suited to cultivated crops because the available water capacity is low and the hazard of erosion is severe. The suitability of this soil for woodland is poor. Seedling mortality is severe because the available water capacity is low. The steep slopes limit the use of equipment.

Slope is the main limitation for buildings. Extensive land shaping is generally needed, and buildings should be designed to conform to the natural slope of the land. Large amounts of cut and fill materials are usually needed when constructing roads on this soil. Roads should be constructed on the contour and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. This soil is poorly suited to septic tank absorption fields because it has moderately steep slopes and does not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground-water supplies. This limitation can be reduced by installing distribution lines close to the surface and placing them across the slope. In some areas additional precautionary measures may be necessary.

This Hubbard soil is in capability subclass VIIs.

8A—Sparta loamy fine sand, 0 to 1 percent slopes. This level, excessively drained soil is on stream terraces and outwash plains. Individual areas are irregular in shape and range from about 5 to 100 acres.

Typically, the surface and subsurface layers combined are loamy fine sand about 12 inches thick. The surface layer is very dark grayish brown, and the subsurface layer is dark brown. The subsoil is dark yellowish brown loamy fine sand or fine sand about 18 inches thick. The underlying material to a depth of about 60 inches is yellowish brown fine sand. In some areas the sand is coarser textured or the surface layer is less than 10 inches thick.

Included with this soil in mapping are small areas of the Dickinson soil. It has a finer textured solum and is in slight depressions. This soil makes up 5 to 10 percent of the map unit.

Permeability of this Sparta soil is moderately rapid in the upper part and rapid in the lower part. The available water capacity is low, and runoff is very slow. Reaction in the subsoil is medium acid or strongly acid. Organic matter content is moderately low.

Most areas of this Sparta soil are cropland. Corn and small grains are the main crops. This soil is poorly suited to crops commonly grown in the area because it has low available water capacity and is subject to late-season drought. Early maturing crops are best suited to this soil. Soil blowing is a management concern, and young plants are easily damaged by blowing sand. Minimum tillage, no-till planting, cover crops, and field windbreaks reduce soil blowing and conserve moisture. This soil is well suited to irrigation; however, frequent applications are needed because of its low available water capacity and rapid permeability.

This soil is fairly suited to pasture and hay. It provides fair pasture in the spring and fall, but during the summer supplemental pastures may be needed to insure adequate production. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain a good cover of the more desirable grasses. Where planting is necessary to improve stands, more drought-resistant plants are needed.

This soil has fair suitability for woodland. Seedling mortality is severe because of the low available water capacity. Drought-tolerant trees should be selected.

This soil is suitable for buildings and local roads. It readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be needed.

This Sparta soil is in capability subclass IVs.

8B—Sparta loamy fine sand, 1 to 6 percent slopes. This gently sloping, excessively drained soil is on stream terraces and outwash plains. Individual areas of this soil are irregular in shape and range from about 5 to 80 acres.

Typically, the surface layer is very dark grayish brown loamy fine sand about 8 inches thick, and the subsurface layer is dark brown loamy fine sand 2 inches thick. The subsoil is dark yellowish brown loamy fine sand or fine sand about 15 inches thick. The underlying material to a depth of about 60 inches is yellowish brown fine sand. In some areas the sand is coarser textured or the surface layer is less than 10 inches thick.

Included with this soil in mapping are small areas of the Dickinson soil. It has a finer textured solum and is slightly higher on the landscape. This soil makes up 5 to 10 percent of the map unit.

Permeability of this Sparta soil is moderately rapid in the upper part and rapid in the lower part. The available water capacity is low, and runoff is slow. Reaction in the subsoil is medium acid or strongly acid. Organic matter content is moderately low.

Most areas of this Sparta soil are cropland. Corn and small grains are the main crops. This soil is poorly suited to crops commonly grown in the area because it has low available water capacity and is subject to late-season drought. Early maturing crops are best suited to this soil. Soil blowing is a management concern, and young plants are easily damaged by blowing sand. Minimum tillage, no-till planting, cover crops, and field windbreaks reduce soil blowing and conserve moisture. This soil is well suited to irrigation; however, frequent applications are needed because the available water capacity is low and permeability is rapid.

This soil is fairly suited to pasture and hay. Droughtiness is a management concern. This soil provides fair pasture in the spring and fall, but during the summer supplemental pastures may be needed to insure adequate production. Proper stocking, rotation grazing, and timely deferment of grazing help keep the soil and pasture in good condition. Where planting is necessary to improve stands, more drought-resistant plants are needed.

This soil has fair suitability for woodland. Seedling mortality is severe because the available water capacity is low. Drought-tolerant trees should be selected.

This soil is suitable for buildings and local roads. It readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Sparta soil is in capability subclass IVs.

12C—Emmert very gravelly sandy loam, 3 to 15 percent slopes. This gently sloping to moderately steep, excessively drained soil is on convex knolls on end moraines. Individual areas are irregular in shape and range from about 3 to 30 acres.

Typically, the surface layer is very dark gravelly sandy loam about 4 inches thick. The subsoil is dark brown and brown very gravelly loamy sand about 18 inches thick. The underlying material to a depth of about 60 inches is strong brown gravelly sand. In some areas coarse fragments are less than 35 percent.

Included with this soil in mapping are a few small areas of the Kingsley soil. It formed in sandy loam glacial till and is in concave positions within the map unit. This soil makes up about 10 percent of the map unit.

The permeability of this Emmert soil is very rapid. The available water capacity is very low, and runoff ranges from slow to medium. Reaction ranges from slightly acid to strongly acid in the subsoil. Organic matter content is low.

Most areas of this soil are used for pasture or are idle. This Emmert soil is poorly suited to pasture and hay because it has very low available water capacity and erosion is a hazard. During the summer supplemental pastures may be needed to insure adequate production. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain a good cover of the more desirable grasses and reduce erosion. Where planting is neccessary to improve plants and yield potential, more drought-resistant plants are needed.

This soil is fairly suited to woodland. Seedling mortality is severe because the available water capacity is very low. Drought-tolerant trees should be selected for planting.

This soil is poorly suited to cultivated crops because it has very low available water capacity. Early maturing crops are best suited to this soil. Minimum tillage, no-till planting, and cover crops reduce erosion and conserve moisture. Some areas of this soil are irrigated; however, frequent applications are needed because the available water capacity is very low.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Emmert soil is in capability subclass IVs.

27A—Dickinson sandy loam, 0 to 2 percent slopes. This nearly level, well drained and somewhat excessively drained soil is on stream terraces and outwash plains.

Individual areas are irregular in shape and range from about 10 to 40 acres.

Typically, the surface layer is very dark brown sandy loam about 13 inches thick. The subsurface layer is very dark grayish brown sandy loam about 3 inches thick. The subsoil is about 20 inches thick. The upper part is dark brown sandy loam, and the lower part is dark brown sand. The underlying material to a depth of about 60 inches is dark brown sand. In some areas the depth to loamy sand or sand is less than 20 inches. In sections 30 and 31 of Ninninger Township, these soils are underlain by reddish silt loam at a depth of 40 to 60 inches.

Included with this soil in mapping are a few small areas of the Hubbard, Sparta, and Wadena soils. The excessively drained Hubbard and Sparta soils have a coarser textured surface layer and subsoil and are slightly higher on the landscape. The well drained Wadena soil has finer textures in the solum and is similar in position to the Dickinson soil. These soils make up about 10 percent of the map unit.

Permeability of this Dickinson soil is moderately rapid in the upper part and rapid in the lower part. The available water capacity is low, and runoff is slow. Reaction in the subsoil ranges from strongly acid to slightly acid. Organic matter content is moderately low.

Most areas of this soil are cropland and are well suited to this use. Corn and soybeans are the main crops. Droughtiness and soil blowing are the main management concerns. Early maturing crops, such as small grains, are best suited to this soil. Using minimum tillage and no-till planting, maintaining a good cover crop, and returning crop residues to the soil conserve available moisture and control soil blowing. This soil is suited to irrigation; however, frequent applications are needed because the water holding capacity is low.

This soil is well suited to pasture and hay. Droughtiness caused by the low available water capacity of the soil is the main management concern. This soil provides fair pasture in the spring, but during the dry summer it produces little forage. Planting drought-resistant forage plants, proper stocking, rotation grazing, fertilizing, and controlling weeds help keep the soil and pasture in good condition. Also, the use of this soil for pasture or hay controls soil blowing.

This soil is suitable for buildings. Constructing roads on well-compacted, coarse textured base material helps protect them from frost damage. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Dickinson soil is in capability subclass IIs. !

27B—Dickinson sandy loam, 2 to 6 percent slopes. This gently sloping, well drained and somewhat excessively drained soil is on stream terraces and outwash plains. Individual areas are irregular in shape and range from about 8 to 20 acres.

Typically, the surface layer is very dark brown sandy loam about 10 inches thick. The subsurface layer is very dark grayish brown sandy loam about 5 inches thick. The subsoil is about 20 inches thick. The upper part is dark brown sandy loam, and the lower part is dark brown sand. The underlying material to a depth of about 60 inches is dark brown sand. In some areas the depth to loamy sand or sand is less than 20 inches. In sections 30 and 31 of Nininger Township, these soils are typically underlain by reddish silt loam at a depth of 40 to 60 inches.

Included with this soil in mapping are some areas of the Hubbard, Sparta, and Zumbro soils. The Hubbard and Sparta soils have coarser textures in the surface layer and subsoil. They are slightly higher on the landscape. The Zumbro soil does not flood, has a thicker dark colored surface layer, and is in swales. These soils make up 2 to 10 percent of the map unit.

Permeability of this Dickinson soil is moderately rapid in the upper part and rapid in the lower part. The available water capacity is low, and runoff is slow. Reaction in the subsoil ranges from strongly acid to slightly acid. Organic matter content is moderately low.

Most areas of this soil are cropland. This soil is well suited to most crops common to the area. Corn and soybeans are the main crops. Droughtiness caused by the low available water capacity and erosion are the main management concerns. Early maturing crops, such as small grains, are best suited to this soil. Using minimum tillage, maintaining a good cover crop, and returning crop residues to the soil conserve the available moisture and control erosion. This soil is suited to irrigation; however, frequent applications are needed because the available water capacity is low.

This soil is well suited to pasture and hay. Erosion and droughtiness caused by the low available water capacity are the major management concerns. This soil provides good pasture in the spring, but during the dry summer supplemental pastures may be needed to insure adequate production. Planting drought-resistant forage plants, proper stocking, rotation grazing, fertilizing, and controlling weeds help keep the soil and pasture in good condition. Also, the use of this soil for pasture or hay effectively controls erosion and soil blowing.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Constructing roads on a well-compacted, coarse textured base material helps protect them from frost damage. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this

limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Dickinson soil is in capability subclass IIe.

39A—Wadena loam, 0 to 2 percent slopes. This nearly level, well drained soil is on outwash plains and stream terraces. Individual areas are irregular in shape and range from about 5 to 100 acres.

Typically, the surface layer is black and very dark brown loam about 12 inches thick. The subsurface layer is very dark grayish brown loam about 4 inches thick. The subsoil is about 19 inches thick. The upper part is dark brown loam, and the lower part is dark yellowish brown sandy loam and loamy sand. The underlying material to a depth of about 60 inches is dark yellowish brown and brown sand. In some areas less than 25 percent sand is in the solum.

Included with this soil in mapping are small areas of the Estherville and Kanaranzi soils. The Estherville soil is excessively drained and is on crests slightly higher in position than the Wadena soil. The Kanaranzi soil has a thinner solum. It is similar in position to the Wadena soil. These soils make up 5 to 15 percent of the map unit.

Permeability of this Wadena soil is moderate in the loamy mantle and rapid in the sandy underlying material. The available water capacity is moderate, and runoff is slow. Reaction in the subsoil ranges from medium acid to neutral. Organic matter content is moderate to high.

Most areas of this soil are cropland. This soil is well suited to crops commonly grown in the area. Corn and soybeans are the main crops. Droughtiness caused by moderate available water capacity reduces crop yields during years of low rainfall. Using minimum tillage, returning crop residue to the soil, and including forage crops in the rotation help retain moisture. This soil is well suited to irrigation.

This soil is well suited to pasture and hay. Droughtiness occasionally limits production during dry years. Where planting is necessary to improve stands, more drought-resistant plants are needed. Proper stocking, rotation grazing, fertilizing, and controlling weeds help maintain a good cover of the more desirable grasses and reduce erosion.

This soil is suitable for buildings and for local roads. It readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Wadena soil is in capability subclass IIs.

39B—Wadena loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on loamy mantled outwash plains and stream terraces. Individual areas are irregular in shape and range from about 5 to 50 acres.

Typically, the surface layer is black and very dark brown loam about 11 inches thick. The subsurface layer is very dark grayish brown loam about 4 inches thick. The subsoil is about 19 inches thick. The upper part is dark brown loam, and the lower part is dark yellowish brown sandy loam and loamy sand. The underlying material to a depth of about 60 inches is dark yellowish brown and brown sand. In some areas less than 25 percent sand is in the solum.

Included with this soil in mapping are small areas of the Estherville and Kanaranzi soils. The Estherville soil is excessively drained and is on crests slightly higher in position than the Wadena soil. The Kanaranzi soil has a thinner solum and is similar in position to the Wadena soil. These soils make up 5 to 15 percent of the map unit.

Permeability of this Wadena soil is moderate in the loamy mantle and rapid in the sandy underlying material. The available water capacity is moderate, and runoff is medium. Reaction in the subsoil ranges from medium acid to neutral. Organic matter content is moderate to high.

Most areas of this soil are cropland. This Wadena soil is well suited to crops commonly grown in the area. Corn and soybeans are the main crops. Erosion is a slight hazard on the steeper slopes. Using minimum tillage, returning crop residue to the soil, and including forage crops in the rotation reduce erosion and improve the available water capacity of the soil. Droughtiness caused by the moderate available water capacity reduces crop yields during years of low rainfall. This soil is well suited to irrigation.

This soil is well suited to pasture and hay. Droughtiness limits production during dry years. Where planting is necessary to improve stands, more drought-resistant plants are needed. Proper stocking, rotation grazing, fertilizing, and controlling weeds help to maintain a good cover of the more desirable grasses and reduce erosion.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. This soil is suitable for road construction. It readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Wadena soil is in capability subclass IIe.

39B2—Wadena loam, 2 to 6 percent slopes, eroded. This gently sloping, well drained soil is on plane to slightly convex positions on loamy mantled outwash plains and in valley trains. Individual areas are irregular in shape and range from about 3 to 50 acres.

Typically, the surface layer is very dark brown loam 9 inches thick. The subsoil is 22 inches thick. The upper part is dark brown loam, and the lower part is dark yellowish brown loam. The underlying material to a depth of about 60 inches is dark yellowish brown and brown gravelly loamy sand and sand. In some areas in the northern third of Egan Township and the northern half of Nininger Township, the upper loamy mantle is less than 18 percent clay and less than 15 percent sand. Also, in some areas the surface layer is more than 10 inches thick. The underlying material in some areas does not have free carbonates above a depth of 60 inches.

Included with this soil in mapping are small areas of the Kennebec soil that formed in silty colluvium in slight depressions. This soil makes up 5 to 10 percent of the map unit.

Permeability of this Wadena soil is moderate in the loamy mantle and rapid in the sandy underlying material. The available water capacity is moderate, and runoff is slow. Reaction of the subsoil ranges from mildly alkaline to medium acid. Organic matter content is moderate.

Most areas of this soil are cropland. This soil is well suited to crops commonly grown in the area. Corn, soybeans, and small grains are the main crops. Erosion is a slight hazard on the steeper slopes. Using minimum tillage, returning crop residue to the soil, and including forage crops in the rotation reduce erosion. Droughtiness caused by the moderate available water capacity reduces crop yields during years of low rainfall. This soil is well suited to irrigation.

This soil is well suited to pasture and hay. Droughtiness limits production during dry years. Proper stocking, rotation grazing, fertilizing, and controlling weeds help to maintain a good cover of the more desirable grasses and reduce erosion.

This soil is suitable for buildings and local roads. It readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Wadena soil is in capability subclass IIe.

39C—Wadena loam, 6 to 12 percent slopes. This sloping, well drained soil is on valley side slopes on loamy mantled outwash plains and stream terraces. Individual areas are irregular in shape and range from about 5 to 20 acres.

Typically, the surface layer is black and very dark brown loam about 10 inches thick. The subsurface layer is very dark grayish brown loam about 4 inches thick. The subsoil is about 17 inches thick. The upper part is dark brown loam, and the lower part is dark yellowish brown sandy loam and loamy sand. The underlying material to a depth of about 60 inches is dark yellowish brown and brown sand. In some areas less than 25 percent sand is in the solum.

Included with this soil in mapping are small areas of the Hawick and Kanaranzi soils. Hawick soil is excessively drained. It is on crests slightly higher in position than the Wadena soil. The Kanaranzi soil has a thinner solum and is similar in position to the Wadena soil. These soils make up 5 to 15 percent of the map unit.

Permeability of this Wadena soil is moderate in the loamy mantle and rapid in the sandy underlying material. The available water capacity is moderate, and runoff is rapid. Reaction in the subsoil ranges from medium acid to neutral. Organic matter content is moderate to high.

Most areas of this soil are cropland. This soil is fairly suited to crops commonly grown in the area. Corn and soybeans are the main crops. Erosion is the main management concern. Minimum tillage, no-till planting, cover crops, and field windbreaks reduce erosion and conserve moisture. Droughtiness caused by the moderate available water capacity occurs during dry periods. Early maturing crops are best suited to this soil. This soil is well suited to irrigation; however, erosion is severe unless controlled.

This soil is fairly suited to pasture and hay. It provides fair pasture in the spring and fall, but during the summer supplemental pastures may be needed to insure adequate production. Proper stocking, rotation grazing, fertilizing, and controlling weeds help to maintain a good cover of the more desirable grasses and reduce erosion. Where planting is necessary to improve stands, more drought-resistant plants are needed. Keeping these areas under continuous cover reduces erosion.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Wadena soil is in capability subclass IIIe.

39C2—Wadena loam, 6 to 12 percent slopes, eroded. This sloping, well drained soil is on convex side slopes on loamy mantled outwash plains and in valley trains. Individual areas are irregular in shape and range from about 5 to 30 acres.

Typically, the surface layer is very dark brown loam about 7 inches thick. The subsoil is about 15 inches thick. The upper part is dark brown loam, and the lower part is dark yellowish brown loam. The underlying material to a depth of about 60 inches is dark yellowish

brown and brown gravelly loamy sand and sand. In some areas in the northern third of Egan Township and the northern half of Nininger Township, the upper loamy mantle is less than 18 percent clay and less than 15 percent sand. In some areas the underlying material does not have free carbonates above a depth of 60 inches.

Included with this soil in mapping are small areas of the Kennebec soil. It formed in silty colluvium in slight depressions. This soil makes up 5 to 10 percent of the map unit.

Permeability of this Wadena soil is moderate in the loamy mantle and rapid in the sandy underlying material. The available water capacity is moderate, and runoff is medium. Reaction in the subsoil ranges from medium acid to mildly alkaline. Organic matter content is moderate.

Most areas of this soil are cropland. This soil is well suited to crops commonly grown in the area. Corn, soybeans, and small grains are the main crops. Erosion is a moderate hazard. Droughtiness during years of low rainfall reduces crop yields. Minimum tillage, no-till planting, cover crops, and field windbreaks reduce erosion and conserve moisture. Early maturing crops are best suited to this soil. This soil is well suited to irrigation.

This soil is well suited to pasture and hay. It provides good pasture in the spring and fall, but during the dry summer supplemental pastures may be needed to insure adequate production. Proper stocking, rotation grazing, fertilizing, and controlling weeds help to maintain a good cover of the more desirable grasses and reduce erosion. Keeping these areas under continuous cover reduces erosion.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Wadena soil is in capability subclass IIIe.

39D—Wadena loam, 12 to 18 percent slopes. This moderately steep, well drained soil is on valley side slopes of loamy mantled outwash plains and stream terraces. Individual areas are irregular in shape and range from about 5 to 15 acres.

Typically, the surface layer is black and very dark brown loam about 10 inches thick. The subsurface layer is very dark grayish loam about 3 inches thick. The subsoil is about 15 inches thick. The upper part is dark brown loam, and the lower part is dark yellowish brown sandy loam and loamy sand. The underlying material to a depth of about 60 inches is dark yellowish brown and brown sand. In some areas less sand is in the solum.

Included with this soil in mapping are small areas of the Hawick and Kanaranzi soils. The Hawick soil is excessively drained. It is on crests slightly higher in position than the Wadena soil. The Kanaranzi soil has a thinner solum and is similar in position to the Wadena soil. These soils make up 5 to 15 percent of the map unit.

Permeability of this Wadena soil is moderate in the loamy mantle and rapid in the sandy underlying material. The available water capacity is moderate, and runoff is very rapid. Reaction in the subsoil ranges from medium acid to neutral. Organic matter content is moderate.

Most areas of this soil are in pasture and hay. This soil is fairly suited to this use. It provides fair pasture in the spring and fall, but during the dry summer supplemental pastures may be needed to insure adequate production. Where planting is necessary to improve stands, more drought-resistant plants are needed. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain a good cover of the more desirable grasses and reduce erosion. Keeping these areas under continuous cover reduces erosion.

This soil is poorly suited to crops commonly grown in the area because of the hazard of erosion and the moderate available water capacity. Minimum tillage, no-till planting, cover crops, and field windbreaks reduce erosion and conserve moisture. Stripcropping and use of terraces also reduce the erosion hazard. The soil is suited to irrigation; however, erosion caused by the very rapid surface runoff is a severe hazard.

Slope is the main limitation for buildings. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope of the land. Large amounts of cut and fill materials are usually needed when constructing roads on this soil. Roads should be constructed on the contour, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be needed. Lines should be installed across the slope.

This Wadena soil is in capability subclass IVe.

41A—Estherville sandy loam, 0 to 2 percent slopes. This nearly level, somewhat excessively drained soil is on outwash plains and stream terraces. Individual areas are irregular in shape and range from about 15 to 200 acres.

Typically, the surface layer is very dark brown sandy loam about 9 inches thick. The subsurface layer is very dark grayish brown sandy loam about 4 inches thick. The subsoil is dark yellowish brown sandy loam and gravelly loamy sand about 8 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown gravelly loamy sand and grayish brown, yellowish brown, and light yellowish brown sand. When mapped in association with the Burkhardt soil, some areas have a redder hue throughout the profile and are leached to a greater depth.

Included with this soil in mapping are small areas of the Wadena soil. It has a higher clay content in the solum and is similar in position to the Estherville soil. This soil makes up 2 to 10 percent of the map unit.

This Estherville soil has moderately rapid permeability in the loamy mantle and rapid permeability in the underlying material. The available water capacity is low, and runoff is slow. Reaction in the subsoil ranges from medium acid to neutral. Organic matter content is moderate.

Most areas of this soil are cropland. This soil is fairly suited to crops commonly grown in the area because it has low available water capacity. Corn and soybeans are the main crops. Early maturing crops are best suited to this soil. Using minimum tillage, returning crop residue to the soil, and including forage crops in the rotation improve the available water capacity and reduce erosion. This soil is well suited to irrigation; however, frequent applications are needed because the available water capacity is low.

This soil is fairly suited to pasture and hay. It provides fair pasture in the spring and fall, but during the summer supplemental pastures may be needed to insure adequate production. Proper stocking, rotation grazing, fertilizing, and controlling weeds help to maintain a good cover of the more desirable grasses.

This soil is suitable for buildings and roads. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Estherville soil is in capability subclass IIIs.

41B—Estherville sandy loam, 2 to 6 percent slopes. This gently sloping, somewhat excessively drained soil is on outwash plains and stream terraces. Individual areas are irregular in shape and range from about 3 to 50 acres.

Typically, the surface and subsurface layers are very dark brown and very dark grayish brown sandy loam and have a combined thickness of about 11 inches. The subsoil is dark yellowish brown sandy loam about 8 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown and grayish brown gravelly loamy sand and sand. When mapped in association with the Burkhardt soil, some areas have a redder hue throughout the profile and are leached to a greater depth.

Included with this soil in mapping are small areas of the Wadena soil. The well drained Wadena soil has a thicker solum and is similar in position to the Estherville soil. This soil makes up 2 to 10 percent of the map unit.

This soil has moderately rapid permeability in the loamy mantle and rapid permeability in the underlying material. The available water capacity is low, and runoff is slow. Reaction in the subsoil is medium acid to neutral. Organic matter content is moderate.

Most areas of this soil are cropland. This soil is just fairly suited to crops commonly grown in the area because it has low available water capacity. Corn and soybeans are the main crops. Early maturing crops are best suited to this soil. Using minimum tillage, returning crop residue to the soil, and including forage crops in the rotation improve the available water capacity and reduce erosion. This soil is well suited to irrigation; however, frequent applications are needed because the available water capacity is low.

This soil is fairly suited to pasture and hay. It provides fair pasture in the spring and fall, but during the summer supplemental pastures may be needed to insure adequate production. Proper stocking, rotation grazing, fertilizing, and controlling weeds help to maintain a good cover of the more desirable grasses and reduce erosion.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. This soil is suitable for road construction. It readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Estherville soil is in capability subclass IIIs.

42C—Salida gravelly coarse sandy loam, 2 to 12 percent slopes. This gently sloping to sloping, excessively drained soil is on convex knolls and side slopes on outwash plains and stream terraces. Individual areas are irregular in shape and range from about 5 to 15 acres.

Typically, the surface layer is very dark grayish brown gravelly coarse sandy loam about 8 inches thick. The subsoil is dark brown gravelly loamy coarse sand about 6 inches thick. The underlying material to a depth of about 60 inches is dark brown and brown very gravelly sand and gravelly sand.

Included with this soil in mapping are small areas of the Hawick soil. It has fewer coarse fragments and is similar in position to the Salida soil. This soil makes up 5 to 10 percent of the map unit.

This Salida soil has very rapid permeability. The available water capacity is very low, and runoff is medium. Reaction in the solum ranges from slightly acid through mildly alkaline. Organic matter content is low.

Most areas of this soil are used for pasture or hay or as a source of sand and gravel. This soil is fairly suited to pasture and hay. It provides fair pasture in spring, but during summer supplemental pastures may be needed to insure adequate production. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain a good cover of the more desirable grasses and reduce erosion. Where planting is necessary to improve stands, more drought-resistant plants are needed. Keeping these areas under continuous cover reduces erosion.

This soil is poorly suited to crops commonly grown in the area because the available water capacity is very low. Early maturing crops are best suited to this soil. Minimum tillage, no-till planting, cover crops, and field windbreaks reduce erosion and conserve moisture. Some areas of this soil are irrigated; however, frequent applications are needed because of the very low available water capacity.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Salida soil is in capability subclass IVs.

49B—Antigo silt loam, 1 to 8 percent slopes. This undulating to rolling, well drained soil is on pitted outwash plains and end moraines. Individual areas are irregular in shape and range from about 3 to 40 acres.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsoil is about 16 inches thick. The upper part is dark brown silt loam, the middle part is yellowish brown silt loam, and the lower part is dark brown silt loam. The underlying material to a depth of about 60 inches is dark brown sand. In some areas the silt loam mantle is more than 40 inches thick.

Included with this soil in mapping are a few small areas of the Chetek soil. It has a sandy loam surface layer and subsoil and is on small, steep side slopes. This soil makes up about 10 percent of the map unit.

Permeability of this Antigo soil is moderate in the upper mantle and rapid in the underlying material. The available water capacity is moderate, and runoff is medium. Reaction in the subsoil ranges from slightly acid to strongly acid. Organic matter content is moderate.

This soil is well suited to cultivated crops. The hazard of erosion and moderate available water capacity are the main management concerns. Using minimum tillage, returning crop residue to the soil, and including forage crops in the rotation reduce erosion and conserve moisture.

This soil is well suited to pasture and hay. Droughtiness limits production during dry years, and supplemental pastures may be needed. Proper stocking, rotation grazing, fertilizing, and controlling weeds help to maintain a good cover of the more desirable grasses and reduce erosion.

This soil is well suited to woodland if competing vegetation is controlled. Pine and spruce are the more desirable trees to plant.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Foundations and footings should be designed to prevent structure damage caused by shrinking and swelling of the soil. Backfilling around foundations with suitable coarse material provides added protection against structure damage. Constructing roads on well-compacted, coarse textured base material protects them from damage caused by low soil strength and frost action. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface.

This Antigo soil is in capability subclass IIe.

81B—Boone loamy fine sand, 2 to 6 percent slopes. This deep, gently sloping, excessively drained soil is on upland foot slopes and ridges. Individual areas are irregular in shape and range from about 5 to 20 acres.

Typically, the surface layer is brown loamy fine sand about 3 inches thick. A transitional layer about 5 inches thick of yellowish brown loamy fine sand is below the surface layer. The underlying material is white fine sand. Weakly cemented sandstone is at a depth of about 24 inches. In some areas the surface layer is very dark brown or dark brown. Also, in some areas the surface and subsurface layers contain up to 60 percent coarse fragments.

Included with this soil in mapping are a few areas of the well drained Etter soil. It has a sandy loam surface layer and loam subsoil and is commonly downslope along the periphery of the Boone soil. This soil makes up about 10 percent of the map unit.

This Boone soil has rapid permeability and low available water capacity. Surface runoff is slow. Reaction in the underlying material ranges from strongly acid to slightly acid. Organic matter content is low. The rooting zone ranges from 20 to 40 inches.

Most areas of this soil are cropland or are idle. This soil is poorly suited to crops commonly grown in the area. Droughtiness and low available water capacity are the major management concerns. Soil blowing is a problem, and young plants are easily damaged by blowing sand. This soil has fair suitability for irrigation. Large quantities of water are required, however, because this soil has low available water capacity and rapid permeability. Using minimum tillage and returning crop residues to the soil help retain moisture and reduce soil blowing.

This soil is poorly suited to pasture. Droughtiness and low available water capacity are the major management concerns. Proper stocking, rotation grazing, fertilizing, and controlling weeds help keep the soil and pasture in good condition. The use of this soil for pasture or hay also effectively controls soil blowing.

This soil is fairly suitable for woodland. Seedling mortality is severe because the available water capacity is low. Practices that entrap rainfall around seedlings provide needed water. Trees commonly grown are northern pin oak, red pine, and jack pine.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Excavating is difficult in some areas because of the underlying bedrock, and large machinery may be required. This soil is suitable for road construction. It is poorly suited to septic tank absorption fields because of the depth to bedrock and poor filtering ability of the soil. The poor filtering ability may result in the pollution of ground-water supplies. The bedrock also hinders the installation of distribution lines in some areas. This limitation can be reduced by installing distribution lines close to the surface, but additional precautionary measures may be necessary.

This Boone soil is in capability subclass IVs.

81C—Boone loamy fine sand, 6 to 12 percent slopes. This deep, sloping, excessively drained soil is on upland knolls and ridges. Individual areas are irregular in shape and range from about 5 to 20 acres.

Typically, the surface layer is brown loamy fine sand about 3 inches thick. A transitional layer is about 4 inches thick. It is yellowish brown loamy fine sand below the surface layer. The underlying material to a depth of about 60 inches is light gray or white fine sand. Some areas have a very dark brown or dark brown surface layer. In some areas the underlying material is strongly cemented sandstone. Also, in some areas the surface and subsurface layers contain up to 60 percent coarse fragments.

Included with this soil in mapping are a few areas of the well drained Etter soil. It has a sandy loam surface layer and loam subsoil and commonly is downslope along the periphery of the Boone soil. This soil makes up about 5 percent of this map unit.

This Boone soil has rapid permeability and low available water capacity. Surface runoff is medium. Reaction in the underlying material ranges from strongly acid to slightly acid. Organic matter content is low.

Most areas of this soil are in pasture or are idle. This soil is poorly suited to pasture or hay. Droughtiness and low available water capacity are the major management concerns. Proper stocking, rotation grazing, fertilizing, and controlling weeds help keep the soil and pasture in good condition. The use of this soil for pasture or hay also effectively controls soil blowing.

This soil is generally unsuitable for cultivated crops because the available water capacity is low and the hazard of erosion is severe. A permanent cover of vegetation should be maintained to control erosion.

This soil is fairly suited to woodland. Seedling mortality is severe because the available water capacity is low. Practices that entrap rainfall around seedlings provide needed water. Trees commonly grown are northern pin oak, red pine, and jack pine.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Excavating is difficult in some areas because of the underlying bedrock, and large machinery may be required. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. This soil is poorly suited to septic tank absorption fields because of the depth to bedrock and because the bedrock does not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground-water supplies. The bedrock also hinders the installation of distribution lines in some areas. These limitations can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Boone soil is in capability subclass VIs.

81E—Boone loamy fine sand, 12 to 40 percent slopes. This deep, moderately steep to very steep, excessively drained soil is on upland ridges and side slopes. Individual areas are commonly elongated and range from about 3 to 40 acres.

Typically, the surface layer is brown loamy fine sand about 2 inches thick. A transitional layer of yellowish brown fine sand about 3 inches thick is below the surface layer. The underlying material to a depth of about 60 inches is light gray or white fine sand. In some areas the underlying material is strongly cemented sandstone. Also, in some areas the surface and subsurface layers contain up to 60 percent coarse fragments.

This Boone soil has rapid permeability and low available water capacity. Surface runoff is rapid. Reaction in the underlying material ranges from strongly acid to slightly acid. Organic matter content is low.

Most areas of this soil are idle. This soil is unsuitable for cultivated crops because slopes are steep, the erosion hazard is severe, and the available water capacity is low. A permanent cover of vegetation should be maintained to control serious erosion.

This soil is poorly suited to woodland. There is a moderate erosion hazard because slopes are steep. Steepness of slope also severely limits operation of tree planting equipment. Seedling mortality is severe.

Slope is the main limitation for buildings. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope of the land. Large amounts of cut and fill materials are usually needed when constructing roads on this soil. Roads should be constructed on the contour and roadbanks planted to well-adapted grasses to minimize the erosion hazard. This soil is poorly suited to septic tank absorption fields because of slope and depth to bedrock. Because the bedrock does not adequately filter the effluent, pollution of ground-water supplies may result. The bedrock also hinders the installation of distribution lines in some areas. If septic tank absorption fields are placed on this soil, distribution lines should be installed on the contour and as close to the surface as possible. Additional precautionary measures may be necessary to overcome the pollution hazard.

This Boone soil is in capability subclass VIIs.

94C—Terril loam, 4 to 12 percent slopes. This gently sloping and sloping, moderately well drained soil is on plane or concave upland foot slopes. Individual areas are elongated and range from about 5 to 15 acres.

Typically, the surface layer is very dark brown loam about 7 inches thick. The subsurface layer is very dark brown loam about 29 inches thick. The subsoil is very dark grayish brown loam about 12 inches thick. The underlying material to a depth of about 60 inches is dark brown loam. In some areas the surface soil and subsoil are silt loam. When mapped in association with the Boone and Etter soils, some areas have more sand in the solum and are underlain by soft sandstone at a depth of 40 to 60 inches.

Permeability of this Terril soil is moderate. The available water capacity is high. Runoff is medium in most areas but is rapid in the more sloping areas. Reaction in the subsoil is slightly acid or neutral. Organic matter content is high.

Most areas of this soil are cropland or permanent pasture and are well suited to these uses. Controlling erosion is the main management concern. Using minimum tillage and returning crop residue to the soil increase infiltration and reduce runoff and erosion. Also, additional cover during seeding and early crop growth help to prevent erosion.

This soil is well suited to pasture and hay. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain an adequate vegetative cover and reduce erosion.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Constructing roads on well-compacted, coarse textured base material helps protect them from damage caused by low soil strength. Land shaping and installing the distribution lines across the slope are generally necessary for the proper operation of septic tank absorption fields.

This Terril soil is in capability subclass IIIe.

98—Colo silt loam, occasionally flooded. This nearly level, poorly drained soil is on flood plains in the lower part of drainageways and in upland depressions. Individual areas are irregular in shape and range from about 3 to 80 acres.

Typically, the surface layer is mottled very dark gray silt loam about 8 inches thick. The next layer is mottled silt loam and silty clay loam about 46 inches thick. It is black in the upper part and very dark gray in the lower part. The underlying material to a depth of about 60 inches is mottled, very dark gray silty clay loam. In some areas of Empire Township, free carbonates are throughout the solum. Also, some small areas are very poorly drained, and in some places strata of loamy sand or sandy loam are below a depth of 4 feet.

Included with this soil in mapping are small areas of the Garwin, Lawson, and Maxfield soils. The Garwin soil does not have dark colored layers below a depth of 24 inches. The Maxfield soil is underlain by loamy glacial till. The Garwin and Maxfield soils are in the upper part of upland drainageways and are not flooded. The Lawson soil is somewhat poorly drained and is slightly higher on the flood plains. These soils make up 5 to 10 percent of the map unit.

This Colo soil has moderate permeability. The available water capacity is high, and runoff is slow. Reaction throughout the profile ranges from slightly acid to neutral. Organic matter content is high. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas of this soil are in woodland or permanent pasture. This soil is well suited to pasture and hay if properly drained. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is well suited to cultivated crops if properly drained. The wetness and seasonal high water table may restrict root growth, cause slow soil warming in the spring, and delay fieldwork. Artificial drainage by tile is needed to lower the water table and improve this soil for optimum growth. The hazard of occasional flooding is a management concern. Fall plowing enables the soil to warm quicker in the spring and provides a seedbed of

improved tilth. It also increases the hazard of erosion; however, terracing helps to keep erosion under control.

This soil is generally not suitable for buildings and septic tank absorption fields because flooding is a hazard. Wetness is a limitation for buildings. Nearby soils are usually better suited to these uses. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts protect them from damage caused by flooding, low soil strength, and frost action.

This Colo soil is in capability subclass IIw.

100A—Copaston loam, 0 to 2 percent slopes. This shallow, nearly level, well drained soil is on upland terraces or benches. Individual areas are irregular in shape and range from about 3 to 40 acres.

Typically, the surface layer is very dark brown loam about 8 inches thick. The subsoil is dark brown and dark yellowish brown loam about 10 inches thick. Hard limestone bedrock is at a depth of about 18 inches. In some areas bedrock is at a depth of less than 12 inches or as much as 40 inches. Some areas are underlain by cemented sandstone.

Included with this soil in mapping are areas where the bedrock outcrops at the surface. These areas make up less than 3 percent of the map unit.

Permeability of the Copaston soil is moderate or moderately rapid. The available water capacity is low, and runoff is slow. Reaction in the subsoil is slightly acid to mildly alkaline. Organic matter content is moderate. The root zone ranges from 12 to 20 inches thick.

Most areas of this soil are used for pasture, hay, and crops. This soil has fair suitability for these uses. It provides good pasture in the spring and fall, but fair to poor pasture in the summer because it has low available water capacity. Proper stocking, rotation grazing, fertilizing, and controlling weeds help keep the pasture and soil in good grazing condition. The use of this soil for pasture or hay also effectively controls erosion.

The shallow depth to bedrock and the low available water capacity are the major limitations to growing crops. Generally, the low available water capacity causes droughtiness during the summer. Early maturing crops, such as small grains, are best suited to this soil. For some crops, the shallow depth to bedrock restricts root penetration. Loose, large fragments of limestone bedrock may damage tillage equipment. This soil is suited to irrigation; however, frequent applications are needed because the available water capacity is low. Using minimum tillage and stubble mulching, returning crop residue to the soil, and applying manure help to conserve moisture.

This soil is poorly suited to buildings and roads because it is shallow to the underlying bedrock. In most areas the bedrock is very hard or cemented, and large machinery is required for excavation. Depth to bedrock limits the use of this soil for septic tank absorption fields and hinders the installation of distribution lines.

This Copaston soil is in capability subclass IIIs.

100B—Copaston loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on convex shoulders of rock cored terraces or benches on uplands. Individual areas are irregular in shape and range from about 3 to 20 acres.

Typically, the surface layer is very dark brown loam about 7 inches thick. The subsoil is dark brown and dark yellowish brown loam about 10 inches thick. Hard limestone bedrock is at a depth of about 18 inches. In some places limestone bedrock is at a depth of less than 12 inches or is as deep as 40 inches. Some areas are underlain by cemented sandstone.

Included with this soil in mapping are areas where the bedrock outcrops at the surface. These areas make up less than 3 percent of the map unit.

Permeability of this Copaston soil is moderate or moderately rapid. The available water capacity is low, and runoff is medium. Reaction in the subsoil is slightly acid to mildly alkaline. Organic matter content is moderate. The root zone ranges from 12 to 20 inches thick.

Most areas of this soil are used for pasture, hay, and crops. This soil has fair suitability for these uses. It provides good pasture in the spring and fall, but fair to poor pasture in the summer because it has low available water capacity. Proper stocking, rotation grazing, fertilizing, and controlling weeds help keep the pasture and soil in good grazing condition. The use of this soil for pasture or hay also effectively controls erosion.

The shallow depth to bedrock, erosion, and the low available water capacity are the major management concerns in growing crops. Generally, the low available water capacity causes droughtiness during the summer. Early maturing crops, such as small grains, are best suited to this soil because they take advantage of early season moisture and help control runoff. For some crops, the shallow depth to bedrock restricts root development. Loose, large fragments of limestone bedrock may damage tillage equipment. This soil is suited to irrigation; however, frequent applications are needed because the available water capacity is low. Using minimum tillage and stubble mulching, returning crop residue to the soil, and applying manure help to conserve moisture and control erosion.

This soil is poorly suited to buildings and roads because it is shallow to bedrock. In most areas excavating very hard or cemented bedrock requires the use of heavy equipment. Shallowness to bedrock limits the use of this soil for septic tank absorption fields and hinders the installation of distribution lines.

This Copaston soil is in capability subclass IIIe.

100C—Copaston loam, 6 to 12 percent slopes. This sloping, well drained soil is on convex shoulders and back slopes of rock-cored terraces or benches on uplands. Individual areas are irregular in shape and range from about 3 to 20 acres.

Typically, the surface layer is very dark brown loam about 6 inches thick. The subsoil is dark brown and dark yellowish brown loam about 9 inches thick. Hard limestone is at a depth of about 15 inches. In some places limestone bedrock is at a depth of less than 12 inches or is as deep as 40 inches. Some areas are underlain by cemented sandstone.

Included with this soil in mapping are areas where the bedrock outcrops at the surface. These areas make up less than 3 percent of the map unit.

Permeability of this Copaston soil is moderate or moderately rapid. The available water capacity is low, and runoff is medium. Reaction in the subsoil is slightly acid to mildly alkaline. Organic matter content is moderate. The root zone ranges from 12 to 20 inches thick.

Most areas of this soil are in permanent pasture or hay. This soil has fair suitability for these uses. It provides good pasture in the spring and fall, but fair to poor pasture in the summer because it has low available water capacity. Planting drought-resistant grasses, proper stocking, rotation grazing, fertilizing, and controlling weeds help keep the pasture and soil in good grazing condition. The use of this soil for pasture or hay also effectively controls erosion.

This soil is poorly suited to cultivated crops. Erosion, shallow depth to bedrock, and low available water capacity are major management concerns in growing crops. Using minimum tillage and stubble mulching, returning crop residue to the soil, and applying manure all help conserve moisture and control erosion. Loose, large fragments of limestone bedrock may damage tillage equipment. This soil is suited to irrigation; however, frequent applications are needed because the available water capacity is low.

This soil is poorly suited to buildings and roads because of slope and shallow depth to bedrock. Extensive land shaping and blasting of bedrock are usually necessary. The underlying bedrock hinders road construction, and heavy machinery is usually required for excavations. Depth to bedrock generally limits the use of this soil as septic tank absorption fields and also hinders the installation of distribution lines.

This Copaston soil is in capability subclass IVe.

106B—Lester loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on ridge crests and side slopes on end moraines. Individual areas are irregular in shape and range from about 5 to 40 acres.

Typically, the surface layer is very dark brown loam about 6 inches thick. The subsoil is about 32 inches thick. It is dark brown loam and clay loam in the upper part and brown loam in the lower part. The underlying material to a depth of about 60 inches is light yellowish brown and light olive brown loam. Some areas of this soil are moderately eroded.

Included with this soil in mapping are a few small areas of the Le Sueur soil. It is moderately well drained to somewhat poorly drained and is in lower lying, less sloping areas than is the Lester soil. This soil makes up less than 10 percent of this map unit.

This Lester soil has moderate permeability. The available water capacity is high, and runoff is medium. Reaction in the subsoil ranges from slightly acid to strongly acid. Organic matter content is moderate.

Most areas of this soil are cropland and are well suited to this use. Corn, soybeans, and small grains are the main crops. Controlling erosion by water on this soil is a management concern. Using minimum tillage, incorporating plant residues into the soil, or farming on the contour increases water infiltration and reduces runoff and erosion.

This soil is well suited to pasture and hay. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods reduce surface compaction and help maintain good grazing conditions.

This soil is well suited to trees. Black walnut, red oak, and silver maple are some of the more desirable trees to plant.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Foundations and footings should be designed to prevent structure damage caused by shrinking and swelling of the soil. Backfilling around foundations with a suitable coarse material provides added protection against structure damage. Constructing roads on well-compacted, coarse textured fill material helps protect them from damage caused by low soil strength. The moderate permeability of this soil restricts its use for septic tank absorption fields, but installing a larger-than-average drainage field helps to overcome this limitation.

This Lester soil is in capability subclass IIe.

106C—Lester loam, 6 to 12 percent slopes. This sloping, well drained soil is on ridge crests and side slopes on end moraines. Individual areas are irregular in shape and range from about 5 to 30 acres.

Typically, the surface layer is very dark brown loam about 6 inches thick. The subsoil is about 30 inches thick. It is dark brown loam and clay loam in the upper part and brown loam in the lower part. The underlying material to a depth of about 60 inches is light yellowish brown and light olive brown loam. Some areas of this soil are moderately eroded.

Included with this soil in mapping are a few small areas of the Le Sueur soil. It is moderately well drained to somewhat poorly drained and is in lower lying, less

sloping areas than is the Lester soil. This soil makes up less than 10 percent of this map unit.

This Lester soil has moderate permeability. The available water capacity is high, and runoff is rapid. Reaction in the subsoil ranges from slightly acid to strongly acid. Organic matter content is moderate.

Most areas of this soil are cropland. This soil is well suited to this use. Corn, soybeans, and small grains are the main crops. Controlling erosion on this soil is the main management concern. Using minimum tillage, incorporating plant residues, terracing, or farming on the contour increase water infiltration and reduce runoff and erosion.

This soil is well suited to pasture and hay. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods reduce surface compaction and erosion and help to maintain good grazing conditions.

This soil is well suited to trees. Black walnut, red oak, and silver maple are some of the more desirable trees to plant.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Foundations and footings should be designed to prevent structure damage caused by shrinking and swelling of the soil. Backfilling around foundations with a suitable coarse material provides added protection against structure damage. Constructing roads on well-compacted, coarse textured base material protects them from damage caused by low soil strength. The slope and moderate permeability of this soil restrict its use for septic tank absorption fields, but installing a larger-than-average drainage field and placing distribution lines across the slope will help to overcome these limitations.

This Lester soil is in capability subclass IIIe.

106C2—Lester loam, 6 to 12 percent slopes, eroded. This sloping, well drained soil is on ridge crests and side slopes on end moraines. Individual areas are irregular in shape and range from about 5 to 20 acres.

Typically, the surface layer is dark brown loam about 6 inches thick. The subsoil is about 30 inches thick. It is dark brown loam and clay loam in the upper part and brown loam in the lower part. The underlying material to a depth of about 60 inches is light yellowish brown and light olive brown loam. In some areas the surface is not eroded.

Included with this soil in mapping are a few small areas of the Le Sueur soil. It is moderately well drained to somewhat poorly drained and is in lower lying, less sloping areas than is the Lester soil. This soil makes up about 5 percent of this map unit.

This Lester soil has moderate permeability. The available water capacity is high, and runoff is rapid. Reaction in the subsoil ranges from slightly acid to strongly acid. Organic matter content is low to moderate.

Most areas of this soil are cropland. This soil is well suited to this use. Corn, soybeans, and small grains are the main crops. Controlling erosion by water on this soil is the main management concern. Using minimum tillage, incorporating plant residues, terracing, or farming on the contour increase water infiltration and reduce runoff and erosion.

This soil is well suited to pasture and hay. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods reduce erosion and surface compaction and help to maintain good grazing conditions.

This soil is well suited to growing trees. Black walnut, red oak, and silver maple are some of the more desirable trees to plant.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Foundations and footings should be designed to prevent structure damage caused by shrinking and swelling of the soil. Backfilling around foundations with a suitable coarse material provides added protection against structure damage. Constructing roads on well-compacted, coarse textured base material protects them from damage caused by low soil strength. The slope and moderate permeability of this soil restrict its use for septic tank absorption fields, but installing a larger-than-average drainage field and placing distribution lines across the slope help to overcome these limitations.

This Lester soil is in capability subclass IIIe.

106D2—Lester loam, 12 to 18 percent slopes, eroded. This moderately steep, well drained soil is on hill crests and side slopes on end moraines. Individual areas are irregular in shape and range from about 5 to 20 acres.

Typically, the surface layer is dark brown loam about 5 inches thick. The subsoil is about 29 inches thick. It is dark brown loam and clay loam in the upper part and brown loam in the lower part. The underlying material to a depth of about 60 inches is light yellowish brown and light olive brown loam. In some areas the surface is not eroded. In the northern third of Farmington corporate limits, this soil formed in firmer glacial till.

This Lester soil has moderate permeability. The available water capacity is high, and runoff is very rapid. Reaction in the subsoil ranges from slightly acid to strongly acid. Organic matter content is low to moderate.

Most areas of this soil are permanent pasture or cropland. This soil is well suited to pasture. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to maintain adequate cover, reduce surface compaction, and control erosion.

This soil is fairly suited to cultivated crops because it has moderately steep slopes. The severe erosion hazard is the main management concern. Using minimum tillage

and incorporating plant residues or forages in the cropping rotation reduce runoff and erosion. Most slopes are too short and irregular for effective contour farming, and the use of farm equipment also is difficult on these steeper slopes.

This soil is fairly suited to woodland. The erosion hazard and the difficulty of operating equipment on these steeper slopes are limitations. Erosion can be reduced by maintaining a good understory ground cover and limiting excessive equipment operation, which destroys this ground cover. Black walnut, red oak, and silver maple are some of the more desirable trees to plant.

Slope is the main limitation for buildings. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope of the land. This soil is poorly suited to road construction because it has moderately steep slopes and low strength. Large amounts of cut and fill material are usually needed, and well-compacted, coarse textured base material should be used to help protect roads from damage caused by low soil strength. Constructing roads on the contour and planting roadbanks to well-adapted grasses minimize the erosion hazard. Land shaping and installing the distribution lines across the slope are generally necessary for septic tank absorption fields to function properly.

This Lester soil is in capability subclass IVe.

109—Cordova silty clay loam. This nearly level, poorly drained soil is in broad swales and slight depressions on end moraines. Individual areas are irregular in shape and range from about 3 to 200 acres.

Typically, the surface layer is black silty clay loam about 16 inches thick. The subsoil is about 18 inches thick. The upper part of the subsoil is very dark gray loam, the middle part is dark gray clay loam, and the lower part is olive gray clay loam. The underlying material to a depth of about 60 inches is mottled, calcareous, olive loam. In some areas the solum and depth to free carbonates are as shallow as 15 inches. In other areas the subsoil has no clay films or the dark surface colors extend below a depth of 24 inches.

Included with this soil in mapping are a few small areas of the Le Sueur soil. It is better drained and is slightly elevated in position. This soil makes up about 5 percent of this map unit.

This Cordova soil has moderately slow permeability. The available water capacity is high, and runoff is slow. Reaction in the subsoil ranges from strongly acid to mildly alkaline. Organic matter content is high. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas of this soil are cropland. This soil is well suited to this use if properly drained. Corn and soybeans are the main crops. The wetness and seasonal high water table restrict root growth, cause slow soil warming in the spring, and delay fieldwork. Artificial drainage may be needed to lower the water table and produce an optimum crop. Fall plowing also enables the soil to warm quicker in the spring and provides a seedbed of improved tilth; however, it increases the hazard of soil blowing.

This soil is well suited to pasture and hay. Some undrained areas are in permanent pasture. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is fairly suited to trees. Plant competition is the main management concern. Seedlings and cuttings survive and grow well if competing vegetation is controlled. Trees to plant are cottonwood and black ash.

This soil is poorly suited to buildings because it is wet. If buildings are constructed on this soil, they should be built without basements, and the landscaping should be designed to drain surface water away from buildings. Tile drains around foundations remove excess subsurface water. Constructing roads on well-compacted, coarse textured base material protects them from damage caused by low soil strength and frost action. The seasonal high water table and the moderately slow permeability of this soil restrict its use for septic tank absorption fields. In some areas, a mound-type absorption field may be suitable.

This Cordova soil is in capability subclass IIw.

113—Webster clay loam. This nearly level, poorly drained soil is in shallow depressions and swales on end moraines. Individual areas are irregular in shape and range from about 3 to 40 acres.

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 16 inches thick. It is mottled, dark grayish brown clay loam in the upper part grading to mottled, grayish brown clay loam. The underlying material to a depth of about 60 inches is mottled, grayish brown clay loam. In some areas, thin strata of silty or sandy material are in the lower part of the profile.

Included with this soil in mapping are a few small areas of the Glencoe and Le Sueur soils. The Glencoe soil is very poorly drained and is lower in position than the Webster soil. The Le Sueur soil is moderately well drained to somewhat poorly drained and is slightly higher in position than the Webster soil. These soils make up 2 to 15 percent of this map unit.

This Webster soil has moderate permeability. The available water capacity is high, and runoff is slow to ponded. Reaction in the subsoil ranges from neutral to mildly alkaline. Organic matter content is high. The seasonal high water table is at a depth of 1 to 2 feet.

Most areas of this soil are drained and used for crops. This soil is well suited to this use. Corn and soybeans are the main crops. The wetness and seasonal high

water table may restrict root growth, cause slow soil warming in the spring, and delay fieldwork. Artificial drainage may be needed to lower the water table and produce an optimum crop. Fall tillage also enables the soil to warm quicker in the spring and provides a seedbed of improved tilth; however, it increases the hazard of soil blowing.

This soil is well suited to pasture and hay. It holds moisture well throughout the growing season. Some undrained areas are in permanent pasture. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is poorly suited to buildings because it is wet. If buildings are constructed on this soil, they should be built without basements, and the landscaping should be designed to drain surface water away from buildings. Tile drains around foundations remove excess subsurface water. Constructing roads on well-compacted, coarse textured base material protects them from damage caused by low soil strength and frost action. This soil is poorly suited to septic tank absorption fields because it has a seasonal high water table. In some areas, a mound-type absorption field may be suitable.

This Webster soil is in capability subclass IIw.

114—Glencoe silty clay loam. This level, very poorly drained soil is in depressions and swales on end moraines. Individual areas are irregular in shape and range from about 3 to 30 acres. This soil is subject to rare flooding or ponding.

Typically, the surface layer is mottled, black silty clay loam and clay loam about 26 inches thick. The subsoil is mottled, grayish brown, clay loam about 12 inches thick. The underlying material to a depth of about 60 inches is mottled, calcareous, grayish brown clay loam. An organic surface layer as much as 10 inches thick is in some areas.

Included with this soil in mapping are a few small areas of the poorly drained Webster soil. It has a thinner surface layer and is in plane to slightly convex areas that are slightly higher than the Glencoe soil. This soil makes up 5 to 10 percent of this map unit.

This Glencoe soil has moderately slow to moderate permeability. The available water capacity is high, and runoff is slow to ponded. Reaction in the subsoil ranges from neutral to mildly alkaline. Organic matter content is high. The seasonal high water table ranges from 1 foot above the surface to 1 foot below.

Most areas of this soil are idle or in permanent pasture. This soil is fairly suited to this use. Grazing when this soil is too wet causes surface compaction and loss of the pasture grasses. Some pastures are very brushy and grazing is poor. These areas can sometimes be cleared, drained, and seeded to moisture-tolerant grasses. Proper stocking, use of moisture-tolerant grasses, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is well suited to crops if properly drained. If not drained, it is generally too wet for high crop yields. Because some areas do not have adequate drainage outlets, drainage may not be feasible. Rare flooding or ponding on this soil is also a management concern. Fall tillage is beneficial because it enables the soil to warm quicker in the spring; however, it increases the hazard of soil blowing.

This soil is generally unsuitable for buildings and septic tank absorption fields because of the ponding hazard. Structure damage to buildings may result because of the low soil strength. Soils that are better suited to these uses are usually nearby. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts protect them from damage caused by ponding, frost action, and low soil strength.

This Glencoe soil is in capability subclass IIIw.

129—Cylinder loam. This nearly level, somewhat poorly drained soil is in slight depressions on loamy-mantled outwash plains and stream terraces. Individual areas are irregular in shape and range from about 5 to 30 acres.

Typically, the surface layer is black and very dark grayish brown loam about 12 inches thick. The subsoil is about 16 inches thick. It is dark brown 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 dark yellowish brown sand. In some areas the surface layer and upper part of the subsoil are silt loam.

Included with this soil in mapping are small areas of the Marshan, Wadena, and Waukegan soils. The Marshan soil is poorly drained and is slightly lower in position than the Cylinder soil. The Wadena and Waukegan soils are well drained and are slightly higher than the Cylinder soil. These soils make up 5 to 10 percent of this map unit.

Permeability of this Cylinder soil is moderate in the loamy mantle and very rapid in the underlying material. The available water capacity is moderate, and runoff is slow. Reaction in the subsoil is slightly acid to neutral. Organic matter content is high. The seasonal high water table is at a depth of 2 to 4 feet.

Most areas of this soil are cropland. This soil is well suited to crops commonly grown in the area. Corn, soybeans, and small grains are the main crops. Droughtiness during years of low rainfall reduces crop yields. Using minimum tillage, returning crop residue to the soil, and including forage crops in the rotation conserve soil moisture and maintain a seedbed of improved tilth. Wetness delays fieldwork in the spring. This soil is well suited to irrigation.

This soil is well suited to pasture and hay. Droughtiness occasionally limits production during dry years, and supplemental pastures may be needed. Proper stocking, rotation grazing, fertilizing, and controlling weeds help to maintain a good cover of the more desirable grasses. Restricted use during wet periods helps to prevent the surface from clodding and compacting.

Buildings with basements should be constructed above the seasonal high water table. Tile drains around foundations remove excess subsurface water. Landscaping should be designed to drain surface water away from buildings. Foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of the soil. Backfilling around foundations with a suitable coarse material provides added protection against structure damage. Constructing roads on well-compacted, coarse textured base material protects them from frost damage. This soil is poorly suited to use as septic tank absorption fields because it has a seasonal high water table and does not adequately filter the effluent. This may result in the pollution of ground-water supplies. Filling or mounding the absorption field with suitable fill material increases the filtering capacity of the soil.

This Cylinder soil is in capability subclass IIs.

150B—Spencer silt loam, 2 to 6 percent slopes. This undulating, moderately well drained soil is in slight depressions and swales on end moraines. Individual areas are irregular in shape and range from about 3 to 15 acres.

Typically, the surface layer is dark grayish brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown silt loam about 6 inches thick. The subsoil is about 32 inches thick. The upper part is yellowish brown and dark yellowish brown silt loam and silty clay loam, and the lower part is mottled, yellowish brown silt loam. The underlying material to a depth of about 60 inches is mottled, dark brown sandy loam.

Included with this soil in mapping are small areas of the poorly drained Auburndale soil and the well drained Otterholt soil. The Auburndale soil is in small depressions. The Otterholt soil is in the more sloping areas. These soils make up about 10 percent of the map unit.

The permeability of this Spencer soil is moderate. The available water capacity is high, and runoff is medium. The reaction of the subsoil ranges from medium acid to strongly acid. The organic matter content is moderate. The seasonal high water table is at a depth of 3 to 6 feet.

This soil is well suited to cultivated crops. Controlling erosion on this soil is a management concern. Using minimum tillage, incorporating plant residues into the soil, and farming on the contour increase water infiltration and reduce runoff and erosion.

This soil is well suited to pasture and hay. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods reduce surface compaction and help to maintain good grazing conditions.

This soil is well suited to trees. Pine, oak, and spruce are some of the desirable trees to plant.

Buildings with basements should be constructed above the seasonal high water table. Tile drains around foundations remove excess subsurface water. Land shaping may be necessary in some areas and should be designed to drain surface water away from buildings. Constructing roads on well-compacted, coarse textured fill material helps to protect them from frost damage. This soil is poorly suited to use as septic tank absorption fields because it has a seasonal high water table. In some areas, a mound-type absorption field may be suitable.

This Spencer soil is in capability subclass IIe.

151C—Burkhardt sandy loam, 6 to 12 percent slopes. This sloping, somewhat excessively drained soil is on convex hills and knolls on uplands. Individual areas are irregular in shape and range from about 5 to 200 acres.

Typically, the surface and subsurface layers combined are sandy loam about 12 inches thick. The surface layer is very dark brown, and the subsurface layer is dark brown. The subsoil is dark reddish brown sandy loam and gravelly sandy loam about 10 inches thick. The underlying material to a depth of about 60 inches is multicolored gravelly coarse sand. In some areas the surface layer is loamy sand. When mapped in association with the Boone and Etter soils, some areas are underlain by loose sandstone.

Included with this soil in mapping are a few small areas of the Carmi soil. This well drained soil formed in finer textured glacial drift and is similar in position to the Burkhardt soil. This soil makes up about 5 percent of the map unit.

The permeability of this Burkhardt soil is moderately rapid in the upper loamy mantle and rapid in the underlying material. The available water capacity is low, and runoff is moderate. Reaction in the subsoil is medium acid or strongly acid. The organic matter content is moderate.

Most areas of this soil are cropland. This soil is fairly suited to crops commonly grown in the area because it has low available water capacity and erosion is a hazard. Minimum tillage, no-till planting, cover crops, and field windbreaks reduce erosion and conserve moisture. Early maturing crops are best suited to this soil. The soil is well suited to irrigation; however, frequent applications are needed because the available water capacity is low.

This soil is fairly suited to pasture and hay. It provides fair pasture in the spring, but during the summer supplemental pastures may be needed to insure

adequate production. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain a good cover of the more desirable grasses and reduce erosion. Where planting is necessary to improve stands, more drought-resistant plants are desirable.

This soil is well suited to woodland. White pine, red pine, and jack pine are some of the more desirable trees to plant.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Burkhardt soil is in capability subclass IVe.

151D—Burkhardt sandy loam, 12 to 18 percent slopes. This moderately steep, somewhat excessively drained soil is on convex side slopes and knolls on uplands. Individual areas are irregular in shape and range from about 5 to 200 acres.

Typically, the surface and subsurface layers combined are sandy loam about 11 inches thick. The surface layer is very dark brown, and the subsurface layer is dark brown. The subsoil is dark reddish brown sandy loam and gravelly sandy loam about 8 inches thick. The underlying material to a depth of about 60 inches is reddish brown and yellowish red gravelly coarse sand. In some areas the surface layer is loamy sand. Where mapped in association with the Boone and Etter soils, some areas are underlain by loose sandstone.

Included with this soil in mapping are a few small areas of the Carmi soil. This well drained soil formed in finer textured glacial drift and is similar in position to the Burkhardt soil. This soil makes up about 5 percent of the map unit.

The permeability of this Burkhardt soil is moderately rapid in the upper loamy mantle and rapid in the underlying material. The available water capacity is low, and runoff is rapid. The subsoil is medium acid or strongly acid. The organic matter content is moderate.

Most areas of this soil are in pasture and hay. This soil is fairly suited to these uses. It provides fair pasture in the spring and fall, but during the summer supplemental pastures may be needed to insure adequate production. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain a good cover of the more desirable grasses and reduce erosion. Where planting is necessary to improve plant stands, more drought-resistant plants are desirable.

This soil is generally unsuitable for cultivated crops mainly because the rapid runoff causes erosion to be a hazard and also because the available water capacity is low. If this soil is used for crops, minimum tillage, no-till planting, and cover crops will reduce erosion and conserve moisture. Early maturing crops are best suited to this soil. The moderately steep slopes limit the use of machinery.

This soil is fairly suited to woodland. Seedling mortality and the hazard of erosion are management concerns because slopes are moderately steep.

Slope is the main limitation for buildings. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope of the land. Large amounts of cut and fill material are usually needed when constructing roads on this soil. Roads should be constructed on the contour, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. This soil is poorly suited to septic tank absorption fields because it has moderately steep slopes and does not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface and placing them across the slope. In some areas additional precautionary measures may be necessary.

This Burkhardt soil is in capability subclass VIe.

155B—Chetek sandy loam, 3 to 8 percent slopes. This undulating to rolling, somewhat excessively drained soil is on end moraines and pitted outwash plains. Individual areas are irregular in shape and range from about 3 to 40 acres.

Typically, the surface and subsurface layers combined are sandy loam about 8 inches thick. The surface layer is very dark brown, and the subsurface layer is very dark grayish brown. The subsoil is about 18 inches thick. The upper part is dark brown loam, and the lower part is strong brown gravelly loamy sand. The underlying material to a depth of about 60 inches is strong brown and yellowish brown gravelly sand. In some areas the underlying sand contains carbonates.

Included with this soil in mapping are a few small areas of the Kingsley and Mahtomedi soils. The well drained Kingsley soil formed in sandy loam glacial till. The excessively drained Mahtomedi soil has sandy surface and subsurface layers and is mostly steeper than the Chetek soil. These included soils make up about 15 percent of the map unit.

The permeability of this Chetek soil is moderately rapid in the loamy surface layer and subsoil and rapid in the underlying sandy material. The available water capacity is low, and runoff is slow. The reaction of the subsoil ranges from strongly acid to slightly acid. The organic matter content is moderate.

This soil is fairly suited to cultivated crops. Droughtiness is the main management concern;

therefore, early maturing crops are best suited to this soil. Using minimum tillage and returning crop residues to the soil help to maintain moisture and reduce erosion.

This soil is fairly suited to pasture. Droughtiness limits forage growth during the dry seasons. The use of legume and grass forage crops in the cropping system reduces erosion, builds up nitrogen in the soil, and improves tilth for future crops.

This soil is fairly suited to woodland. Drought-tolerant trees, such as pines, grow best.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. This soil is suitable for road construction. It readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be needed.

This Chetek soil is in capability subclass IIIs.

155C—Chetek sandy loam, 8 to 15 percent slopes. This rolling to hilly, somewhat excessively drained soil is on end moraines and pitted outwash plains. Individual areas are irregular in shape and range from about 3 to 30 acres.

Typically, the surface and subsurface layers combined are sandy loam about 7 inches thick. The surface layer is very dark brown, and the subsurface layer is very dark grayish brown. The subsoil is about 17 inches thick. The upper part is dark brown loam, and the lower part is strong brown gravelly loamy sand. The underlying material to a depth of about 60 inches is strong brown and yellowish brown gravelly sand. In some areas the underlying material contains carbonates.

Included with this soil in mapping are a few small areas of the Kingsley and Mahtomedi soils. The well drained Kingsley soil formed in sandy loam glacial till. The excessively drained Mahtomedi soil has a sandy surface layer and subsoil and is mostly in the steeper areas. These soils make up about 15 percent of the map unit.

The permeability of this Chetek soil is moderately rapid in the loamy surface layer and subsoil and rapid in the underlying sandy layers. The available water capacity is low, and runoff is medium. The reaction of the subsoil ranges from slightly acid to strongly acid. The organic matter content is moderate.

This soil is fairly suited to cultivated crops. Erosion is the main management concern, but it can be reduced by using minimum tillage or by including hay in the cropping system. Contour farming is often difficult on the short, irregular slopes. Early maturing crops are best suited to this soil.

The potential of this soil for pasture is fair. Late-season droughtiness often limits forage production. Overgrazing can cause erosion. The use of legume and grass forage crops in the cropping system reduces erosion, builds up nitrogen in the soil, and improves tilth.

This soil is fairly suited to woodlands. Drought-tolerant plants, such as pines, grow best.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas, additional precautionary measures may be needed.

This Chetek soil is in capability subclass IVe.

155E—Chetek sandy loam, 15 to 25 percent slopes. This hilly to steep, somewhat excessively drained soil is on pitted outwash plains and end moraines. Individual areas are irregular in shape and range from about 3 to 20 acres.

Typically, the surface and subsurface layers combined are sandy loam about 5 inches thick. The surface layer is very dark brown, and the subsurface layer is very dark grayish brown. The subsoil is about 12 inches thick. The upper part is dark brown loam, and the lower part is strong brown gravelly loamy sand. The underlying material to a depth of about 60 inches is strong brown and yellowish brown gravelly sand. In some areas the underlying material contains carbonates.

Included with this soil in mapping are a few small areas of the Kingsley and Mahtomedi soils. The well drained Kingsley soil formed in sandy loam till. This soil makes up about 5 percent of the map unit. The excessively drained Mahtomedi soil is in the steeper areas of the map unit. This soil makes up about 10 percent of the map unit.

The permeability of this Chetek soil is moderately rapid in the loamy surface layer and subsoil and rapid in the underlying sandy layers. The available water capacity is low, and runoff is rapid. Reaction of the subsoil ranges from slightly acid to strongly acid. The organic matter content is moderate.

This soil is generally unsuitable for cultivated crops. Erosion is the main management concern but can be minimized by maintaining a solid vegetative cover. Droughtiness limits crop growth during dry seasons.

The potential of this soil for pasture is poor. Droughtiness limits forage growth during dry seasons; therefore, supplemental pastures may be needed to insure adequate production. Overgrazing causes erosion.

This soil is fairly suited to woodland. Seedling mortality is a problem because the available water capacity is low and runoff is rapid. Drought-tolerant trees, such as pines

should be selected. The steeper areas pose a problem for equipment.

Slope is the main limitation for buildings. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope of the land. Large amounts of cut and fill material are usually needed when constructing roads on this soil. Roads should be constructed on the contour and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. This soil is poorly suited to septic tank absorption fields because slopes are steep and the soil does not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface and placing them across the slope. Additional precautionary measures may be needed to overcome the pollution hazard.

This Chetek soil is in capability subclass VIe.

173F—Frontenac loam, 25 to 40 percent slopes. This very steep, well drained soil is on north- and east-facing convex side slopes of dissected terrain. Individual areas are elongated and range from about 10 to 75 acres.

Typically, the surface and subsurface layers combined are loam about 11 inches thick. The surface layer is black, and the subsurface layer is very dark grayish brown. The subsoil is dark brown and dark yellowish brown loam about 13 inches thick. The underlying material to a depth of about 60 inches is calcareous, yellowish brown flaggy loam. Some areas have a thinner subsoil, and some have limestone bedrock outcrops. Also included in mapping are some areas that have slopes of more than 40 percent.

Permeability of this Frontenac soil is moderate in the upper part and moderately rapid in the underlying material. The available water capacity is moderate, and runoff is very rapid. Reaction in the subsoil is medium acid to neutral. Organic matter content is high.

Most areas of this soil are in woodland. Trees grow well on this soil; however, very steep slopes make it poorly suited to woodland management. Seedling mortality and erosion are severe limitations, and equipment is difficult to operate. Terracing can be used to entrap rainfall around seedlings, thereby reducing seedling mortality and excessive runoff and erosion. Erosion can be reduced by limiting the excessive equipment operations that remove undergrowth and natural leaf-mulch ground cover. Recommended trees to plant include eastern white pine, red pine, and American basswood.

This soil is not suited to cultivated crops because slopes are very steep and the hazard of erosion is severe. Some areas are suitable for wooded pasture; however, steep slopes restrict access for renovation and seeding of desirable pasture grasses.

This soil is fairly suited to habitat for woodland wildlife. If used for this purpose, areas should be managed to protect existing habitat and to maintain or improve its quality. Management for wildlife habitat also enhances these areas for scenic purposes.

Slope is the main limitation for buildings. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope of the land. Large amounts of cut and fill materials are usually needed when constructing roads on this soil. Roads should be constructed on the contour, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. Land shaping and installing the distribution lines across the slope are generally necessary for septic tank absorption fields to function properly.

This Frontenac soil is in capability subclass VIIe.

176—Garwin silty clay loam. This nearly level, poorly drained soil is in broad swales and at the head of upland drainageways. Individual areas are irregular in shape and range from about 3 to 20 acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. The next layer is mottled, very dark gray silty clay loam about 6 inches thick. The subsoil is about 28 inches thick. The upper part is mottled, dark grayish brown silty clay loam; the middle part is mottled, grayish brown silty clay loam; and the lower part is mottled, grayish brown silt loam. The underlying material to a depth of about 60 inches is mottled, grayish brown silt loam. In some areas glacial till is as shallow as 40 inches.

Included with this soil in mapping are a few small areas of the Colo and Joy soils. The Colo soil floods, has a dark colored surface layer to a depth of more than 24 inches, and is in lower parts of drainageways. The Joy soil is somewhat poorly drained and is slightly higher in position than the Garwin soil. These soils make up 2 to 10 percent of this map unit.

This Garwin soil has moderate permeability. The available water capacity is very high, and runoff is slow. Reaction in the subsoil ranges from medium acid to neutral. Organic matter content is high. The seasonal high water table is at a depth of 1 to 2 feet.

Most areas of this soil are cropland, and it is well suited to this use if properly drained. Corn and soybeans are the main crops. The wetness and seasonal high water table restrict root growth, cause slow soil warming in the spring, and delay fieldwork. Artificial drainage is needed to lower the water table and improve this soil for optimum crop growth. Fall tillage enables the soil to warm quicker in the spring and provides a seedbed of improved tilth; however, it can increase the hazard of soil blowing.

This soil is well suited to pasture and hay. It holds moisture well throughout the growing season. Some undrained areas of this soil are in permanent pasture.

Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

Buildings with basements should be constructed above the seasonal high water table. Tile drains around foundations remove excess subsurface water. Landscaping should be designed to drain surface water away from buildings. Foundations and footings should be designed to prevent structure damage caused by shrinking and swelling of the soil. Backfilling around foundations with a suitable coarse material provides added protection against structure damage. Constructing roads on well-compacted, coarse textured base material helps to protect them from damage caused by frost action, low soil strength, and shrinking and swelling of the soil. This soil is poorly suited to septic tank absorption fields because it has a seasonal high water table. In some places, a mound-type absorption field may be suitable.

This Garwin soil is in capability subclass IIw.

177A—Gotham loamy fine sand, 0 to 2 percent slopes. This nearly level, somewhat excessively drained soil is on uplands, stream terraces, and outwash plains. Individual areas are irregular in shape and range from about 3 to 90 acres.

Typically, the surface layer is very dark grayish brown loamy fine sand about 9 inches thick. The subsoil is about 39 inches thick. The upper 16 inches is dark brown loamy fine sand, and the lower part is dark yellowish brown and dark brown fine sand. The underlying material to a depth of about 60 inches is dark brown fine sand. In some areas the profile contains more medium and coarse sand, and in others the surface layer is thicker and darker colored. The subsoil in some areas does not have the characteristic lamellae.

Included with this soil in mapping are small areas where loamy glacial till is within 40 to 60 inches of the surface. They are similar in position to the Gotham soil and make up 3 to 6 percent of the map unit.

Permeability of this Gotham soil is moderately rapid in the upper part and rapid in the underlying material. The available water capacity is low, and runoff is slow. Reaction in the subsoil ranges from strongly acid to neutral. Organic matter content is low.

Most areas of this soil are cropland. This soil is fairly suited to crops commonly grown in the area. Its main limitation is its low available water capacity. Corn and small grains are the main crops. Early maturing crops are best suited to this soil. Minimum tillage, no-till planting, cover crops, and field windbreaks reduce erosion and conserve moisture. This soil is well suited to irrigation; however, frequent applications are needed because the available water capacity is low.

This soil is fairly suited to pasture and hay. It provides fair pasture in the spring, but during the summer supplemental pastures may be needed to insure adequate production. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain a good cover of the more desirable grasses and reduce erosion. Where planting is necessary to improve stands, more drought-resistant plants are needed. Keeping these areas under continuous cover reduces erosion.

This soil is well suited to woodland. Seedling mortality is a problem because the available water capacity is low. Drought-tolerant trees, such as red pine or jack pine, should be selected for planting.

This soil is suitable for buildings and roads. It readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Gotham soil is in capability subclass IVs.

177B—Gotham loamy fine sand, 2 to 6 percent slopes. This gently sloping, somewhat excessively drained soil is on uplands, stream terraces, and outwash plains. Individual areas are irregular in shape and range from about 3 to 30 acres.

Typically, the surface layer is very dark grayish brown loamy fine sand about 8 inches thick. The subsoil is about 39 inches thick. The upper 16 inches is dark brown loamy fine sand, and the lower part is dark yellowish brown and dark brown fine sand. The underlying material to a depth of about 60 inches is dark brown and dark yellowish brown fine sand. In some areas the profile contains more medium and coarse sand, and in others the surface layer is thicker and darker colored. The subsoil in some areas does not have the characteristic lamellae.

Included with this soil in mapping are small areas where loamy glacial till is within 40 to 60 inches of the surface. They are similar in position to the Gotham soil and make up 3 to 6 percent of the map unit.

Permeability is moderately rapid in the upper mantle and rapid in the underlying material. The available water capacity is low, and runoff is slow. Reaction in the subsoil ranges from strongly acid to neutral. Organic matter content is low.

Most areas of this soil are cropland. This soil is poorly suited to crops commonly grown in the area because it has low available water capacity. Early maturing crops are best suited to this soil. Minimum tillage, no-till planting, cover crops, and field windbreaks reduce erosion and conserve moisture. This soil is well suited to irrigation; however, frequent applications are needed because the available water capacity is low.

This soil is fairly suited to pasture and hay. It provides fair pasture in the spring, but during the summer

supplemental pastures may be needed to insure adequate production. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain a good cover of the more desirable grasses and reduce erosion. Where planting is necessary to improve stands, more drought-resistant plants are needed. Keeping the areas under continuous cover reduces erosion.

This soil is well suited to woodland. Seedling mortality is a problem because the available water capacity is low. Drought-tolerant trees, such as red pine or jack pine, should be selected for planting.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. This soil is suitable for roads. It readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Gotham soil is in capability subclass IVs.

177C—Gotham loamy fine sand, 6 to 12 percent slopes. This sloping, somewhat excessively drained soil is on uplands, stream terraces, and outwash plains. Individual areas are irregular in shape and range from about 5 to 40 acres.

Typically, the surface layer is very dark grayish brown loamy fine sand about 7 inches thick. The subsoil is about 39 inches thick. The upper 16 inches is dark brown loamy fine sand, and the lower part is dark yellowish brown and dark brown fine sand. The underlying material to a depth of about 60 inches is dark brown and dark yellowish brown fine sand. In some areas the profile contains more medium and coarse sand. The subsoil in some areas does not have the characteristic lamellae.

Included with this soil in mapping are small areas where loamy glacial till is within 40 to 60 inches of the surface. They are in convex positions and make up 3 to 5 percent of the map unit.

Permeability of this Gotham soil is moderately rapid in the upper mantle and rapid in the underlying material. The available water capacity is low, and runoff is moderate. Reaction in the subsoil ranges from strongly acid to neutral. Organic matter content is low.

Most areas of this soil are cropland. This soil is poorly suited to crops commonly grown in the area because it has low available water capacity. Early maturing crops are best suited to this soil. Minimum tillage, no-till planting, cover crops, terraces, and field windbreaks reduce erosion and conserve moisture. This soil is well suited to irrigation; however, frequent applications are needed because of the low available water capacity.

This soil is fairly suited to pasture and hay. It provides fair pasture in the spring, but during the summer supplemental pastures may be needed to ensure adequate production. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain a good cover of the more desirable grasses and reduce erosion. Where planting is necessary to improve stands, more drought-resistant plants are needed. Keeping these areas under continuous cover reduces erosion.

This soil is well suited to woodland. Seedling mortality may be a problem because the available water capacity is low. Drought-tolerant trees, such as red pine or jack pine, should be selected for planting.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Gotham soil is in capability subclass IVs.

189—Auburndale silt loam. This nearly level, poorly drained soil is in shallow depressions on end moraines. Individual areas are irregular in shape and range from about 3 to 30 acres. This soil is subject to ponding.

Typically, the surface layer is very dark grayish brown silt loam about 13 inches thick. The subsurface layer is mottled, grayish brown silt loam about 12 inches thick. The subsoil is mottled, grayish brown silt loam about 11 inches thick. The underlying material to a depth of about 60 inches is mottled, grayish brown silt loam underlain by dark brown sandy loam. In some areas the surface layer is thicker and darker or it contains more sand. Also, some areas are somewhat poorly drained and do not flood.

Included with this soil in mapping are small areas of very poorly drained Quam soil, commonly toward the center of the delineation. This soil makes up less than 10 percent of the map unit.

Permeability of this Auburndale soil is moderate to moderately slow. The available water capacity is high, and runoff is slow to ponded. Reaction in the subsoil ranges from strongly acid to medium acid. Organic matter content is high or very high. The seasonal high water table ranges from 1 foot above to 1 foot below the soil surface.

This soil is suited to woodland. Wetness limits the use of equipment and is a factor in tree selection. Plant competition is severe. Controlling weeds, cultivating, and applying herbicides help remove competing plants.

This soil is generally unsuitable for cultivated crops unless properly drained. However, because adjacent

slopes are steep and there is no suitable drainage outlet, drainage is impractical.

This soil is fairly suited to pasture. Grazing when this soil is too wet causes surface compaction and destruction of pasture grasses. Proper stocking, use of moisture-tolerant grasses, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is generally unsuitable for buildings or septic tank absorption fields because ponding is a hazard. Soils that are better suited to these uses are usually nearby. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect them from damage caused by ponding, frost action, and low soil strength.

This Auburndale soil is in capability subclass VIw.

203B—Joy silt loam, 1 to 5 percent slopes. This gently sloping, somewhat poorly drained soil is on foot slopes on loess-mantled uplands. Individual areas are irregular in shape and range from about 5 to 25 acres.

Typically, the surface layer is black silt loam about 14 inches thick. The subsurface layer is dark brown silt loam about 9 inches thick. The subsoil is dark grayish brown and olive brown, mottled silt loam about 32 inches thick. The underlying material to a depth of about 60 inches is olive brown, mottled silt loam. In some areas the underlying material is glacial till.

Included with this soil in mapping are a few small areas of the Garwin and Port Byron soils. The Garwin soil is poorly drained and is in broad drainageways. The Port Byron soil is well drained and is higher in position than the Joy soil. These soils make up 2 to 10 percent of this map unit.

This Joy soil has moderate permeability. The available water capacity is high, and runoff is moderate. Reaction in the subsoil ranges from strongly acid to neutral. Organic matter content is high. The seasonal high water table is at a depth of 2 to 4 feet.

Most areas of this soil are cropland, and it is well suited to this use. Corn, soybeans, and small grains are the main crops. This soil is very productive because it has a high available water capacity. The steeper slopes are susceptible to erosion by water. Incorporating plant residues into the soil, using minimum tillage, or farming on the contour reduces the hazard of erosion. Wetness delays fieldwork in the spring.

This soil is well suited to pasture and hay. Overstocking when the soil is too wet causes surface compaction and increases runoff. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

Buildings with basements should be constructed above the seasonal high water table. Landscaping should be designed to drain surface water away from buildings. Constructing roads on well-compacted, coarse textured fill material protects them from damage caused by low soil strength and frost action. This soil is poorly suited to septic tank absorption fields because it has a seasonal high water table. In some areas, a mound-type absorption field may be suitable.

This Joy soil is in capability subclass IIe.

208—Kato silty clay loam. This nearly level, poorly drained soil is on outwash plains and flood plains. Individual areas are irregular in shape and range from about 20 to 50 acres. This soil is subject to rare flooding.

Typically, the surface layer is black silty clay loam about 12 inches thick. The subsurface layer is very dark gray silty clay loam about 11 inches thick. The subsoil is about 10 inches thick. The upper part is olive gray silt loam, and the lower part is olive gray loamy sand. The underlying material to a depth of about 60 inches is very dark grayish brown sand. In some areas, a higher percentage of sand is in the solum. Also, in some areas, the surface layer is more than 24 inches thick. Along the Vermillion River, these soils are flooded more frequently.

Included with this soil in mapping are some small areas of the Cylinder soil. It is somewhat poorly drained and is higher in position than the Kato soil. This Cylinder soil makes up about 5 percent of this map unit.

Permeability of the Kato soil is moderate in the silty mantle and rapid in the underlying material. The available water capacity is moderate, and runoff is slow. Reaction in the subsoil ranges from medium acid to neutral. Organic matter content is high to very high. The seasonal high water table is at a depth of 1 to 2.5 feet.

Most areas of this soil are cropland. This soil is well suited to this use if properly drained. Corn and soybeans are the main crops. The wetness and seasonal high water table restrict root growth, cause slow soil warming in the spring, and delay fieldwork. Artificial drainage may be needed to lower the water table and improve this soil for optimum crop growth. Fall tillage causes the soil to warm quicker in the spring and provides a seedbed of improved tilth; however, it can increase the hazard of soil blowing.

This soil is well suited to pasture and hay; however, grazing when the soil is too wet causes surface compaction and clodding. Artificial drainage and seeding with moisture-tolerant grasses and legumes improve pasture and hay production. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is generally unsuitable for buildings or septic tank absorption fields because of the flooding hazard. Soils that are better suited to these uses are usually nearby. Constructing roads on well-compacted, coarse textured fill material helps to protect them from damage caused by low soil strength and frost action.

This Kato soil is in capability subclass IIw.

213B—Klinger silt loam, 1 to 5 percent slopes. This gently sloping, somewhat poorly drained soil is on the foot slopes of till plains. Individual areas are irregular in shape and range from about 5 to 40 acres.

Typically, the surface layer is black and very dark grayish brown silt loam about 13 inches thick. The subsoil is about 42 inches thick. The upper part, in the silty mantle, is dark grayish brown silt loam grading to dark brown loam high in silt, and the lower part is mottled, yellowish brown and grayish brown loam. The underlying material to a depth of about 60 inches is mottled, calcareous, grayish brown loam. In some areas about 12 inches of sand and gravel is between the silty mantle and the till.

Included with this soil in mapping are small areas of the Maxfield and Ostrander soils. The poorly drained Maxfield soil is in drainageways. The well drained Ostrander soil is on high spots and the steeper slopes. These soils make up 5 to 10 percent of this map unit.

This Klinger soil has moderate permeability. The available water capacity is high, and runoff is medium. Reaction in the subsoil ranges from strongly acid to neutral. Organic matter content is high. The seasonal high water table is at a depth of 2 to 4 feet.

Most areas of this soil are cropland, and it is well suited to this use. Corn, soybeans, and small grains are the main crops. This soil is very productive because it has a high available water capacity. The more sloping areas are susceptible to erosion by water. Incorporating plant residues into the soil, using minimum tillage, and farming on the contour reduce this problem. Wetness delays fieldwork in the spring.

This soil is well suited to pasture and hay. Overstocking when the soil is too wet causes surface compaction and increases runoff. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

Buildings with basements should be constructed above the seasonal high water table. Tile drains around foundations remove excess subsurface water. Landscaping should be designed to drain surface water away from buildings. Foundations and footings should be designed to prevent structure damage caused by shrinking and swelling of the soil. Backfilling around foundations with suitable coarse material provides added protection against structure damage. Constructing roads on well-compacted, coarse textured base material protects them from damage caused by low soil strength and frost action. This soil is poorly suited to septic tank absorption fields because it has a seasonal high water table. In some areas, a mound-type absorption field may be suitable.

This Klinger soil is in capability subclass IIe.

226—Lawson silt loam. This nearly level, somewhat poorly drained soil is on bottom land near major streams. Individual areas are irregular in shape and range from about 10 to 65 acres. This soil is subject to occasional flooding.

Typically, the surface layer is very dark brown silt loam about 8 inches thick. The subsurface layer is dark brown silt loam about 22 inches thick. The underlying material to a depth of about 60 inches is dark grayish brown silt loam. In some areas, thin lenses of silt or very fine sand are between depths of 30 and 40 inches.

Included with this soil in mapping are small areas of the Colo and Minneiska soils. The Minneiska soil is moderately well drained and is on natural levees. It makes up 5 to 10 percent of this map unit.

Permeability of this Lawson soil is moderate. The available water capacity is very high, and runoff is slow. Reaction ranges from slightly acid to mildly alkaline. Organic matter content is moderate. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas of this soil are in woodland and are well suited to this use. Existing woodland can be improved for commercial harvesting by thinning out the mature and undesirable trees. Recommended trees to plant are silver maple and white ash.

This soil is well suited to crops. Occasional flooding is a management concern, Wetness also delays fieldwork. Draining this soil is impractical, however, except on a regional basis.

This soil is well suited to pasture and hay. Productivity is good for all recommended forage crops. Grazing in the early spring and after heavy rains should be delayed to prevent pasture damage and soil compaction. Proper stocking, rotation grazing, controlling weeds, and fertilizing are good management practices.

This soil is generally unsuitable for buildings or septic tank absorption fields because of the flooding hazard. Soils that are better suited to these uses are usually nearby. Constructing roads on raised, well-compacted fill material and providing adequate side ditches and culverts help protect them from flood and frost damage.

This Lawson soil is in capability subclass IIw.

239—Le Sueur loam. This nearly level, moderately well drained to somewhat poorly drained soil is on lower side slopes on end moraines. Individual areas are irregular in shape and range from about 5 to 60 acres.

Typically, the surface layer is very dark brown loam high in silt. It is about 10 inches thick. The subsoil is about 43 inches thick. The upper part is mottled, dark brown silty clay loam and loam. The lower part is mottled, olive brown clay loam. The underlying material to a depth of about 60 inches is mottled, light olive brown loam. In some areas the surface layer is silt loam as much as 14 inches thick.

Included with this soil in mapping are a few small areas of the Cordova and Lester soils. The poorly drained Cordova soil is slightly lower in position than the Le Sueur soil. The well drained Lester soil is in slightly

elevated spots and in the more sloping areas. These soils make up 5 to 15 percent of this map unit.

Permeability of this Le Sueur soil is moderate. The available water capacity is high, and runoff is slow. Reaction in the subsoil ranges from strongly acid to neutral. Organic matter content is moderate. The depth to the seasonal high water table is 2 to 4 feet.

Most areas of this soil are cropland, and it is well suited to this use. Corn, soybeans, and small grains are the main crops. This soil is one of the most productive in the county because it has a high available water capacity and little slope. Fall plowing allows the soil to warm quicker in the spring and provides a seedbed of improved tilth. Keeping tillage to a minimum reduces soil blowing.

This soil is well suited to pasture and hay. Proper grazing and weed control help to maintain an adequate cover of the more productive plants.

This soil is well suited to trees. Seedling mortality, equipment limitations, and erosion hazard are slight. Plant competition is severe. Seedlings and cuttings survive and grow well, however, if competing vegetation is controlled.

Buildings with basements should be constructed above the seasonal high water table. Tile drains around foundations remove excess subsurface water. Landscaping should be designed to drain surface water away from the buildings. Foundations and footings should be designed to prevent structure damage caused by shrinking and swelling of the soil. Backfilling around foundations with suitable coarse material provides added protection against structure damage. Constructing roads on well-compacted, coarse textured base material protects them from damage caused by low soil strength and frost action. This soil is poorly suited to septic tank absorption fields because it has a seasonal high water table. In some places, a mound-type absorption field may be suitable.

This Le Sueur soil is in capability class I.

250—Kennebec silt loam. This nearly level, moderately well drained soil is in depressions and drainageways on outwash plains. Individual areas are irregular in shape and range from about 2 to 10 acres. This soil is subject to occasional flooding or ponding.

Typically, the surface layer is very dark brown silt loam about 12 inches thick. The subsurface layer is black silt loam about 29 inches thick. The underlying material to a depth of about 60 inches is mottled, very dark gray and dark brown silt loam. In some areas the surface layer contains more than 10 percent sand, and the sand is as shallow as 50 inches.

This Kennebec soil has moderate permeability. The available water capacity is very high, and runoff is slow to ponded. Reaction in the solum ranges from medium acid to neutral. Organic matter content is high. The seasonal high water table is at a depth of 3 to 5 feet.

Most areas of this soil are cropland, and it is well suited to this use. Corn, soybeans, and small grains are the main crops. Occasional flooding is a management concern. Wetness also delays fieldwork in the spring. Using minimum tillage, including forage in the cropping rotation, and returning crop residue to the soil help to maintain tilth.

This soil is well suited to pasture and hay. Productivity is good for all recommended forage crops. Grazing in the early spring and after heavy rains should be delayed to prevent pasture damage and soil compaction. Proper stocking, rotation grazing, controlling weeds, and fertilizing are good management practices.

This soil is well suited to trees. Plant competition is the main management concern. Existing woodland can be improved by thinning out the mature and undesirable trees.

This soil is generally unsuitable for buildings or septic tank absorption fields because of the flooding hazard. Soils that are better suited to these uses are usually nearby. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help to protect them from damage caused by flooding, low soil strength, and frost action.

This Kennebec soil is in capability subclass IIw.

251D—Marlean loam, 12 to 18 percent slopes. This moderately steep, well drained soil is on convex side slopes of dissected uplands and in stream valleys. Individual areas are elongated and range from about 5 to 40 acres.

Typically, the surface layer is black loam about 5 inches thick. The subsoil is very dark grayish brown loam about 6 inches thick. The underlying material is very channery loam and contains about 65 percent coarse fragments. Limestone bedrock is at a depth of about 42 inches. In some areas limestone bedrock is less than 18 inches deep and, in a few areas, outcrops at the surface.

Included with this soil in mapping are a few small areas of the Terril soil. It formed in loamy colluvial sediments on foot slopes. This soil makes up about 5 percent of the map unit.

The permeability of this Marlean soil is moderate in the loamy sediments and moderately rapid in the fragmented limestone. The available water capacity is low, and runoff is rapid. The reaction of the subsoil is neutral to slightly acid. Organic matter content is moderate.

Most areas of this soil remain in the native hardwoods and are valued as scenic landscapes. This soil is fairly suited to habitat for woodland wildlife. If used for this purpose, areas should be managed to protect existing habitat and to maintain or improve its quality. Management for wildlife habitat also enhances these areas for scenic purposes.

In some areas the lower slopes are used for permanent pasture but are poorly suited to this use

because they are droughty and erosion is a hazard. Proper stocking, pasture rotation, and timely deferment of grazing control erosion and help to maintain the most desirable forage plants.

This soil is generally unsuitable for cultivated crops because it has low available water capacity, erosion is a hazard, and machinery is difficult to operate on these moderately steep slopes.

Slope is the main limitation for buildings. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope of the land. Large amounts of cut and fill materials are usually needed when constructing roads on this soil. Roads should be constructed on the contour, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. Land shaping and installing the distribution lines across the slope are generally necessary for septic tank absorption fields to function properly.

This Marlean soil is in capability subclass VIIe.

251E—Marlean loam, 18 to 25 percent slopes. This steep, well drained soil is on convex side slopes of dissected uplands and in stream valleys. Individual areas are elongated and range from about 5 to 30 acres.

Typically, the surface layer is black loam about 4 inches thick. The subsoil is very dark grayish brown loam about 6 inches thick. The underlying material is channery loam and contains about 65 percent coarse fragments. Limestone bedrock is at a depth of about 40 inches. In some areas limestone bedrock is less than 18 inches deep and, in a few areas, outcrops at the surface.

Included with this soil in mapping are a few small areas of Terril soil. It formed in loamy colluvial sediments on foot slopes. This soil makes up 5 percent of the map unit.

The permeability of this Marlean soil is moderate in the loamy sediments and moderately rapid in the fragmented limestone. The available water capacity is low, and runoff is very rapid. The reaction of the subsoil is neutral to slightly acid. Organic matter content is moderate.

Most areas of this soil remain in native hardwoods and are valued as scenic landscapes. This soil is fairly suited to habitat for woodland wildlife. If used for this purpose, areas should be managed to protect existing habitat and to maintain or improve its quality. Management for wildlife habitat also enhances these scenic areas.

In some areas the lower slopes are used for permanent pasture but are poorly suited to this use because they are droughty and erosion is a hazard. Proper stocking, pasture rotation, and timely deferment of grazing help control erosion and maintain the most desirable forage plants.

This soil is generally unsuitable for cultivated crops because it has a low available water capacity, erosion is a hazard, and operating machinery on these steep slopes is difficult.

Slope is the main limitation for buildings. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope of the land. Large amounts of cut and fill materials are usually needed when constructing roads on this soil. Roads should be constructed on the contour, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. Land shaping and installing the distribution lines across the slope are generally necessary for the proper operation of septic tank absorption fields.

This Marlean soil is in capability subclass VIIe.

252—Marshan silty clay loam. This nearly level, poorly drained soil is on loamy mantled outwash plains and stream terraces. Individual areas are irregular in shape and range from about 20 to 70 acres.

Typically, the surface layer is black silty clay loam and loam about 14 inches thick. The subsoil is dark gray, grayish brown, and olive gray loam about 18 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown and grayish brown sand. Included with this soil in mapping are small areas in which the solum contains less sand. A thin organic layer is less than 4 inches thick in some areas.

Included with this soil in mapping are small areas of the Cylinder soil. The somewhat poorly drained Cylinder soil is slightly elevated in position. Some areas, near the Vermillion River, are subject to rare flooding. This soil makes up 5 to 10 percent of the map unit.

Permeability of this Marshan soil is moderate in the upper loamy mantle and rapid in the underlying sandy material. The available water capacity is moderate, and runoff is slow. Reaction in the subsoil is slightly acid or neutral. Organic matter content is high. The depth to the seasonal high water table is 1 to 2.5 feet.

Most areas of this soil are cropland. This soil is well suited to this use if properly drained. Corn and soybeans are the main crops. The wetness and seasonal high water table restrict root growth, cause slow soil warming in the spring, and delay fieldwork. Artificial drainage may be needed to lower the water table and improve this soil for optimum crop growth. Fall tillage causes the soil to warm quicker in the spring and provides a seedbed of improved tilth; however, it increases the hazard of soil blowing.

This soil is well suited to pasture and hay; however, grazing when the soil is too wet causes surface compaction and clodding. Artificial drainage and seeding with wetness-tolerant grasses and legumes improve pasture and hay production. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is generally unsuitable for buildings or septic tank absorption fields because it is wet and has poor filtering capacity. Soils that are better suited to these uses are usually nearby. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect them from damage caused by frost action and low soil strength.

This Marshan soil is in capability subclass IIw.

253—Maxcreek silty clay loam. This nearly level, poorly drained soil is in slight depressions and at the heads of drainageways on end moraines. Individual areas are irregular in shape and range from about 3 to 20 acres.

Typically, the surface layer is black silty clay loam about 13 inches thick. The subsurface layer is very dark gray silty clay loam about 4 inches thick. The subsoil is about 13 inches thick. The upper part is mottled, dark grayish brown silty clay loam, and the lower part is mottled, grayish brown silty clay loam. The underlying material to a depth of about 60 inches is mottled, light olive brown loam. In some areas a partially sorted layer as much as 5 inches thick and containing as much as 10 percent coarse fragments is at the base of the upper silty sediments. In some places the overlying silty sediments extend to a depth of more than 48 inches.

Included with this soil in mapping are a few small areas of the Merton soil. It is moderately well drained to somewhat poorly drained and is slightly higher than the Maxcreek soil. This soil makes up 2 to 10 percent of the map unit.

This Maxcreek soil has moderate permeability. The available water capacity is high, and runoff is slow. Reaction in the subsoil ranges from neutral to mildly alkaline. Organic matter content is high. The seasonal high water table is at a depth of 0 to 3 feet.

Most areas of this soil are cropland. This soil is well suited to this use if properly drained. Corn and soybeans are the main crops. The wetness and seasonal high water table restrict root growth, cause the soil to warm slowly in the spring, and delay fieldwork. Artificial drainage may be needed to lower the water table for optimum crop growth. Fall tillage causes the soil to warm quicker in the spring and provides a seedbed of improved tilth; however, it increases the hazard of soil blowing.

This soil is well suited to pasture and hay. Some undrained areas are in permanent pasture. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

Buildings with basements should be constructed above the seasonal high water table. Tile drains around foundations remove excess subsurface water. Landscaping should be designed to drain surface water away from buildings. Foundations and footings should be designed to prevent structure damage caused by shrinking and swelling of the soil. Backfilling around foundations with suitable coarse material provides added protection against structure damage. Constructing roads on well compacted, coarse textured base material helps to protect them from damage caused by frost action, low soil strength, and shrinking and swelling of the soil. This soil is poorly suited to septic tank absorption fields because it has a seasonal high water table. In some places, a mound-type absorption field may be suitable.

This Maxcreek soil is in capability subclass IIw.

255—Mayer silt loam. This nearly level, poorly drained soil is on loamy-mantled outwash plains and stream terraces. Individual areas are irregular in shape and range from about 10 to 50 acres.

Typically, the surface layer is black silt loam about 17 inches thick. The subsoil is about 14 inches thick. The upper part is mottled, grayish brown loam, and the lower part is mottled, olive sandy loam. The underlying material to a depth of about 60 inches is brown gravelly loamy sand. In some areas the surface layer is organic and about 10 inches thick.

Included with this soil in mapping are small areas of the Cylinder soil. It is somewhat poorly drained and is slightly higher than the Mayer soil. It makes up 5 to 10 percent of this map unit.

This Mayer soil has moderate permeability in the upper mantle and rapid permeability in the underlying material. The available water capacity is moderate, and runoff is slow. Reaction in the subsoil is mildly alkaline to moderately alkaline. Organic matter content is high. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas of this soil are cropland. This soil is well suited to this use if properly drained. Corn and soybeans are the main crops. The wetness and seasonal high water table restrict root growth, cause slow soil warming in the spring, and delay fieldwork. Artificial drainage may be needed to lower the water table and improve this soil for optimum crop growth. Fall tillage causes the soil to warm quicker in the spring and provides a seedbed of improved tilth; however, it increases the hazard of soil blowing.

This soil is well suited to pasture and hay; however, grazing when the soil is too wet causes surface compaction and clodding. Artificial drainage and seeding with grasses and legumes that tolerate wetness improve pasture and hay production. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is poorly suited to buildings because it is wet. If buildings are constructed on this soil, they should be built without basements, and landscaping should be designed to drain surface water away from buildings. Tile drains around foundations remove excess subsurface

water. Constructing roads on well-compacted, coarse textured base material protects them from damage caused by low soil strength and frost action. This soil is poorly suited to septic tank absorption fields because it has a seasonal high water table. In some places, a mound-type absorption field may be suitable.

This Mayer soil is in capability subclass IIw.

279B—Otterholt silt loam, 1 to 6 percent slopes. This undulating, well drained soil is on side slopes and broad hill crests on end moraines. Individual areas are irregular in shape and range from about 5 to 60 acres.

Typically, the surface layer is very dark grayish brown silt loam about 2 inches thick. The subsurface layer is brown silt loam about 9 inches thick. The subsoil is about 24 inches thick. It is dark yellowish brown silt loam and has clay films on the surfaces of peds. The underlying material to a depth of about 60 inches is reddish brown sandy loam grading to dark brown loam. In some areas the silt loam mantle is less than 30 inches thick.

Included with this soil in mapping are a few small areas of the Auburndale and Kingsley soils. The poorly drained Auburndale soil is in small depressions. The Kingsley soil formed in sandy loam glacial till. These soils make up about 15 percent of the map unit.

The permeability of this Otterholt soil is moderate. The available water capacity is high, and runoff is medium. The reaction of the subsoil is medium acid to strongly acid. The organic matter content is moderate.

This soil is well suited to cultivated crops; however, it erodes easily. Using minimum tillage, including hay crops in the rotation, and returning crop residues to the soil minimize erosion. Contour farming may be difficult because of the short, irregular slopes.

This soil is well suited to pasture and hay. Including legume and grass forage in the cropping system reduces erosion, builds up nitrogen in the soil, and improves tilth for future crops. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain the most productive plants.

This soil is well suited to woodlands. Most trees grow well if competing vegetation is controlled.

If buildings are constructed on this soil, foundations and footings should be designed to prevent structure damage caused by shrinking and swelling of the soil. Backfilling around foundations with suitable coarse material provides added protection against structure damage. Constructing roads on well-compacted, coarse textured base material helps to protect them from damage caused by low soil strength and frost action. The moderate permeability of this soil restricts its use for septic tank absorption fields, but installing a larger-than-average drainage field will help to overcome this limitation.

This Otterholt soil is in capability subclass IIe.

279C—Otterholt silt loam, 6 to 15 percent slopes. This rolling to hilly, well drained soil is on side slopes and broad hill crests on end moraines. Individual areas are irregular in shape and range from about 5 to 40 acres.

Typically, the surface layer is very dark grayish brown silt loam about 2 inches thick. The subsurface layer is brown silt loam about 8 inches thick. The subsoil is about 20 inches thick. It is dark yellowish brown silt loam that contains clay films. The underlying material to a depth of about 60 inches is reddish brown sandy loam grading to dark brown loam. In some areas the silt loam is less than 30 inches thick.

Included with this soil in mapping are a few small areas of the Auburndale and Kingsley soils. The Auburndale soil is poorly drained and is in shallow depressions. The Kingsley soil formed in sandy loam glacial till. These soils make up about 15 percent of the map unit.

Permeability of the Otterholt soil is moderate. The available water capacity is high, and runoff is rapid. The reaction of the subsoil is medium acid to strongly acid. The organic matter content is moderate.

This soil is well suited to cultivated crops; however, it is easily eroded. Using minimum tillage, returning crop residues to the soil, and including hay in the crop rotation reduce erosion. Contour farming or terracing may be difficult because of the short, irregular slopes.

This soil is well suited to pasture and hay. Erosion is the main management concern. The use of legume and grass forage in the cropping system reduces erosion, builds up nitrogen in the soil, and improves tilth for future crops. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain the most productive plants.

This soil is well suited to woodland. Most trees grow well if competing vegetation is controlled.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Foundations and footings should be designed to prevent structure damage caused by shrinking and swelling of the soil. Backfilling around foundations with suitable coarse material provides added protection against structure damage. Constructing roads on well-compacted, coarse textured base material helps protect them from damage caused by low soil strength and frost action. The slope and moderate permeability restrict the use of this soil for septic tank absorption fields, but installing a larger-than-average drainage field and placing distribution lines across the slope will help to overcome these limitations.

This Otterholt soil is in capability subclass IIIe.

283A—Plainfield loamy sand, 0 to 2 percent slopes. This nearly level, excessively drained soil is on outwash plains and stream terraces. Individual areas are irregular in shape and range from about 3 to 50 acres.

Typically, the surface layer is very dark brown loamy sand about 4 inches thick. The subsoil is dark yellowish brown and yellowish brown sand about 24 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, brownish yellow, and light yellowish brown sand. In some areas the sands are finer textured or the surface layer is more than 4 inches thick.

Included with this soil in mapping are small areas of the Dickinson soil. This soil has a finer textured solum and is slightly higher than the Plainfield soil. This soil makes up about 5 to 10 percent of the map unit.

Permeability of the Plainfield soil is moderately rapid in the upper mantle and rapid in the underlying material. The available water capacity is low, and runoff is slow. Reaction in the subsoil ranges from strongly acid to neutral. Organic matter content is low.

Most areas of this soil are cropland. This soil is poorly suited to crops commonly grown in the area because the available water capacity is low. Early maturing crops are best suited to this soil. Soil blowing is a problem and easily damages young plants. Using minimum tillage and no-till planting, including cover crops in the cropping system, and installing field windbreaks reduce soil blowing and conserve moisture. This soil is well suited to irrigation, however, frequent applications are needed because it has a low available water capacity and rapid permeability.

This soil is fairly suited to pasture and hay. It provides fair pasture in the spring, but during the summer supplemental pastures may be needed to ensure adequate production. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain a good cover of the more desirable grasses. Where planting is necessary to improve stands, more drought-resistant plants are needed.

This soil is fairly suited to woodland. Seedling mortality may be a problem because the available water capacity is low. Drought-tolerant trees, such as red pine or jack pine, should be selected for planting.

This soil is suitable for buildings and roads. It readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Plainfield soil is in capability subclass IVs.

283B—Plainfield loamy sand, 2 to 6 percent slopes. This gently sloping, excessively drained soil is on outwash plains and stream terraces. Individual areas are irregular in shape and range from about 10 to 250 acres.

Typically, the surface layer is very dark brown loamy sand about 4 inches thick. The subsoil is dark yellowish brown and yellowish brown sand about 24 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, brownish yellow, and light yellowish brown sand. In some areas the sands are finer textured or the surface layer is more than 4 inches thick.

Included with this soil in mapping are small areas of the Dickinson soil. This soil has a finer textured solum and is slightly elevated in position. This soil makes up 5 to 10 percent of the map unit.

Permeability of this Plainfield soil is moderately rapid in the upper mantle and rapid in the underlying material. The available water capacity is low, and runoff is slow. Reaction in the subsoil ranges from strongly acid to neutral. Organic matter content is low.

Most areas of this soil are cropland. This soil is poorly suited to crops commonly grown in the area because it has a low available water capacity. Early maturing crops are best suited to this soil. There is a slight hazard of erosion on the stronger slopes. Soil blowing is a problem and easily damages young plants. Using minimum tillage and no-till planting, including cover crops in the cropping system, and installing field windbreaks reduce soil blowing and erosion and help to conserve moisture. This soil is well suited to irrigation; however, frequent applications are needed because it has a low available water capacity and rapid permeability.

This soil is fairly suited to pasture and hay. It provides fair pasture in the spring, but during the summer supplemental pastures may be needed to ensure adequate production. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain a good cover of the more desirable grasses and reduce erosion. Where planting is necessary to improve stands, more drought-resistant plants are needed.

This soil is fairly suited to woodland. Seedling mortality may be a problem because the available water capacity is low. Drought-tolerant trees, such as red pine or jack pine, should be selected for planting.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. This soil is suitable for road construction. It readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Plainfield soil is in capability subclass IVs.

283D—Plainfield loamy sand, 6 to 18 percent slopes. This sloping to moderately steep, excessively drained soil is on side slopes on outwash plains and in stream valleys. Individual areas are long and narrow and range from about 5 to 15 acres.

Typically, the surface layer is black loamy sand about 3 inches thick. The subsoil is dark yellowish brown and yellowish brown sand about 20 inches thick. The underlying material to a depth of about 60 inches is

yellowish brown, brownish yellow, and light yellowish brown sand. In some places the sands are finer textured.

Included with this soil in mapping are small areas of the Hawick soil. This soil has more coarse fragments and is similar in position to the Plainfield soil. This soil makes up about 5 to 10 percent of the map unit.

Permeability of this Plainfield soil is moderately rapid in the upper mantle and rapid in the underlying material. The available water capacity is low. Surface runoff is generally medium, but it is rapid in the more sloping areas. Reaction in the subsoil ranges from strongly acid to neutral. Organic matter content is low.

This soil is generally not suited to cultivated crops because the available water capacity is low and the hazard of erosion is severe. Soil blowing is also a management concern, and young plants are easily damaged. Some areas of this soil are irrigated; however, frequent applications are needed because it has a low available water capacity and rapid permeability. If this soil is irrigated, intensive erosion-control measures are needed to keep the soil loss within acceptable limits.

Most areas of this soil are in pasture and hay and it is fairly suited to this use. It provides fair pasture in the spring and fall, but during the summer supplemental pastures may be needed to ensure adequate production. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain a good cover of the more desirable grasses and reduce erosion. Where planting is necessary to improve stands, more drought-resistant plants are needed. Keeping these areas under continuous cover reduces erosion.

This soil is fairly suited to woodland. Seedling mortality is severe because the available water capacity is low and runoff is rapid. Equipment use is difficult on the steeper slopes.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Plainfield soil is in capability subclass VIIs.

285A—Port Byron silt loam, 0 to 2 percent slopes. This nearly level, well drained soil is on broad ridges and hilltops on loess-mantled uplands. Individual areas are irregular in shape and range from about 5 to 30 acres.

Typically, the surface layer is black silt loam about 14 inches thick. The subsurface layer is very dark grayish brown silt loam about 5 inches thick. The subsoil is dark yellowish brown silt loam about 33 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown silt loam. In a few areas, the surface layer is less than 10 inches thick and the subsoil contains more clay.

Included with this soil in mapping are a few small areas of the Lindstrom soil. It has a thicker surface layer and is in shallow depressions and heads of drainageways. This soil makes up about 5 percent of the map unit.

This Port Byron soil has moderate permeability. The available water capacity is very high, and runoff is slow. The reaction of the subsoil is medium acid to slightly acid. The organic matter content is high.

Most areas of this soil are cropland, and it is well suited to that use. Corn, soybeans, and small grains are the main crops. Using minimum tillage and returning crop residues to the soil improve tilth and increase infiltration.

This soil is well suited to pasture and hay. Including legume and grass forage in the cropping system reduces erosion, builds up nitrogen in the soil, and improves tilth for future crops. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain the most productive plants.

This soil is suitable for buildings. Constructing roads on well-compacted, coarse textured base material protects them from damage caused by low soil strength and frost action. This soil is suitable for use as septic tank absorption fields.

This Port Byron soil is in capability class I.

285B—Port Byron silt loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on side slopes and hill crests on loess-mantled uplands. Individual areas are irregular in shape and range from about 5 to 60 acres.

Typically, the surface layer is black silt loam about 12 inches thick. The subsurface layer is very dark grayish brown silt loam about 4 inches thick. The subsoil is dark yellowish brown silt loam about 32 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown silt loam. In some areas the surface layer is less than 10 inches thick and the subsoil contains more clay.

Included with this soil in mapping are a few small areas of the Lindstrom soil. It has a thicker surface layer and is in shallow depressions or upper parts of drainageways. This soil makes up about 10 percent of the map unit.

The permeability of this Port Byron soil is moderate. The available water capacity is very high, and runoff is medium. The reaction of the subsoil is medium acid to slightly acid. The organic matter content is high.

Most areas of this soil are cropland. This soil is well suited to all crops commonly grown in the area. Corn, soybeans, and small grains are the main crops. This soil is easily eroded by water. Leaving crop residue on the surface, by minimum tillage or by stubble mulching,

increases infiltration and reduces runoff and erosion. Maintaining extra cover during seeding and leaving the early crop growth on the soil help to prevent erosion. Farming on the contour also reduces erosion.

This soil is well suited to pasture and hay. Including legume and grass forage in the cropping system reduces erosion, builds up nitrogen in the soil, and improves tilth for future crops. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain the most productive plants.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Constructing roads on well-compacted, coarse textured base material helps protect them from damage caused by low soil strength and frost action. This soil is suitable for septic tank absorption fields.

This Port Byron soil is in capability subclass IIe.

285C—Port Byron silt loam, 6 to 12 percent slopes. This sloping, well drained soil formed on side slopes of loess-mantled uplands. Individual areas are irregular in shape and range from about 5 to 80 acres.

Typically, the surface layer is black silt loam about 10 inches thick. The subsurface layer is very dark grayish brown silt loam about 4 inches thick. The subsoil is dark yellowish brown silt loam about 30 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown silt loam. In some areas the surface layer is thinner and the subsoil contains more clay. Also, in some places calcareous silt loam is within 30 inches of the surface.

Included with this soil in mapping are a few small areas of the Lindstrom soil. It has a thicker surface layer and is in shallow depressions or the upper part of drainageways. This soil makes up about 10 percent of the map unit.

The permeability of this Port Byron soil is moderate. The available water capacity is very high, and runoff is rapid. The reaction of the subsoil ranges from medium acid to slightly acid. The organic matter content is high.

Most areas of this soil are used for cultivated crops, and it is well suited to that use. Corn, soybeans, and small grains are the main crops. This soil erodes easily, but using minimum tillage, farming on the contour, terracing, and including cover crops in the cropping system reduce erosion and runoff.

This soil is well suited to pasture and hay. Including legume and grass forage in the cropping system reduces erosion, builds up nitrogen in the soil, and improves tilth for future crops. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain the most productive plants, reduce erosion, and keep the soil in good condition.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Constructing roads on well-compacted, coarse textured base material helps protect them from damage caused by low soil strength and frost action. Land shaping and installing the distribution lines across the slope are generally necessary for septic tank absorption fields to function properly.

This Port Byron soil is in capability subclass IIIe.

299A—Rockton loam, 0 to 2 percent slopes. This nearly level, well drained soil is on bedrock-cored terraces or broad crests of uplands. Individual areas are irregular in shape and range from about 3 to 50 acres.

Typically, the surface layer is black and very dark grayish brown loam about 16 inches thick. The subsoil is dark brown clay loam about 19 inches thick. It is underlain by limestone bedrock. In some areas, limestone bedrock ranges from less than 20 to more than 40 inches from the surface.

The permeability of the Rockton soil is moderate above the bedrock. The available water capacity is low to moderate, and runoff is slow. Reaction in the subsoil ranges from strongly acid to slightly acid. Organic matter content is high. The root zone ranges from 20 to 40 inches deep.

Most areas of this soil are cropland, and it is well suited to this use. Corn, soybeans, and small grains are the main crops. Droughtiness during years of low rainfall reduces crop yields because the available water capacity is low to moderate. Using minimum tillage and stubble mulching, returning crop residue to the soil, and applying manure conserve available moisture.

This soil is well suited to pasture and hay. It provides good pasture in the spring and fall and fair pasture in the summer when the available moisture is low. Proper stocking, rotation grazing, fertilizing, and controlling weeds help to maintain a good cover of the more desirable grasses and keep the soil in good grazing condition.

If buildings are constructed on this soil, foundations and footings should be designed to prevent structure damage caused by shrinking and swelling of the soil. Backfilling around foundations with suitable coarse material provides added protection against structure damage. Excavation is difficult in some areas because of the underlying bedrock, and large machinery may be required. Constructing roads on well-compacted, coarse textured base material helps protect them from damage caused by low soil strength and frost action. This soil is poorly suited to septic tank absorption fields because it is shallow to bedrock. The bedrock hinders the installing of distribution lines.

This Rockton soil is in capability subclass IIs.

299B—Rockton loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on convex shoulders and backslopes of bedrock-cored terraces or uplands.

Individual areas are irregular in shape and range from about 3 to 50 acres.

Typically, the surface layer is black and very dark grayish brown loam about 16 inches thick. The subsoil is dark brown clay loam about 19 inches thick. It is underlain by limestone bedrock. In some areas limestone bedrock is less than 20 inches deep or more than 40 inches deep. Where mapped in association with the Tallula soil, the surface layer and subsoil are silt loam.

The permeability of this Rockton soil is moderate above the bedrock. The available water capacity is low to moderate, and runoff is medium. Reaction in the subsoil ranges from strongly acid to slightly acid. Organic matter content is high. The root zone ranges from 20 to 40 inches deep.

Most areas of this soil are cropland. This soil is well suited to this use. Corn, soybeans, and small grains are the main crops. The main management concerns are erosion and droughtiness. Droughtiness during years of low rainfall reduces crop yields because the available water capacity is low to moderate. Early maturing crops, such as small grains, are well suited to this soil and help control runoff. Using minimum tillage and stubble mulching, returning crop residue to the soil, and applying manure help to conserve the available moisture and control erosion.

This soil is well suited to pasture and hay. It provides good pasture in the spring and fall and fair pasture in the summer when the available moisture is low. Proper stocking, rotation grazing, fertilizing, and controlling weeds help to maintain a good cover of the more desirable grasses and keep the soil in good grazing condition. The use of this soil for pasture or hay also effectively controls erosion.

If buildings are constructed on this soil, foundations and footings should be designed to prevent structure damage caused by shrinking and swelling of the soils. Backfilling around foundations with suitable coarse material provides added protection against structure damage. Excavation is difficult in some areas because of the underlying bedrock, and large machinery may be required. Buildings should be designed to conform to the natural slope of the land. Constructing roads on well-compacted, coarse textured base material helps to protect them from damage caused by low soil strength and frost action. This soil is poorly suited to septic tank absorption fields because it is shallow to bedrock. The bedrock hinders the installing of distribution lines.

This Rockton soil is in capability subclass IIe.

299C—Rockton loam, 6 to 12 percent slopes. This sloping, well drained soil is on convex shoulders and backslopes of bedrock-cored terraces or uplands. Individual areas are irregular in shape and range from about 3 to 35 acres.

Typically, the surface layer is black and very dark grayish brown loam about 12 inches thick. The subsoil is dark brown clay loam about 15 inches thick. It is underlain by limestone bedrock. In some areas limestone bedrock is less than 20 inches or more than 40 inches deep. Also, in some areas the bedrock outcrops at the surface. Where mapped in association with Tallula soil, the surface layer and subsoil are silt loam.

The permeability of this Rockton soil is moderate above the bedrock. The available water capacity is low to moderate, and runoff is rapid. Reaction in the subsoil ranges from strongly acid to slightly acid. Organic matter content is high. The root zone ranges from 20 to 40 inches deep.

Most areas of this soil are cropland. This soil has fair suitability for this use. Corn, soybeans, and small grains are the main crops. Management concerns are erosion and droughtiness. Using minimum tillage and stubble mulching, farming on the contour, returning crop residue to the soil, and applying manure help to conserve the available moisture and control erosion. Droughtiness during years of low rainfall reduces crop yields. Early maturing crops, such as small grains, are well suited to this soil and help control runoff.

This soil is well suited to pasture and hay. It provides good pasture in the spring and fall and fair pasture in the summer when the available moisture is low. Proper stocking, rotation grazing, fertilizing, and controlling weeds help to maintain a good cover of the more desirable grasses and keep the soil in good grazing condition. The use of this soil for pasture or hay also effectively controls erosion.

If buildings are constructed on this soil, foundations and footings should be designed to prevent structure damage caused by shrinking and swelling of the soil. Backfilling around foundations with suitable coarse material provides added protection against structure damage. Excavation is difficult in some areas that have a core of bedrock, and large machinery may be required. Buildings should be designed to conform to the natural slope of the land. Constructing roads on well-compacted, coarse textured base material helps to protect them from damage caused by low soil strength and frost action. They should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. This soil is poorly suited to septic tank absorption fields because it is shallow to bedrock. The bedrock hinders the installing of distribution lines.

This Rockton soil is in capability subclass IIIe.

301B—Lindstrom silt loam, 1 to 4 percent slopes. This well drained soil is in slightly concave parts of upland drainageways and on lower foot slopes. Individual areas are elongated and range from about 5 to 30 acres.

Typically, the surface layer is black silt loam about 8 inches thick. The subsurface layer is black and very dark grayish brown silt loam about 26 inches thick. The subsoil extends to a depth of about 60 inches. It is dark

brown and dark yellowish brown silt loam. In some areas dark grayish brown mottles are below a depth of 50 inches. Also, in some places the subsoil is loam.

Permeability of this Lindstrom soil is moderate. The available water capacity is very high, and runoff is medium. Reaction in the subsoil is medium acid to neutral. Organic matter content is moderate.

Most areas of this soil are used for crops. This soil is well suited to this use. Corn, soybeans, and small grains are the main crops. Using this soil for row crops can cause erosion. Minimum tillage, rotations that include forage crops, the return of crop residue to the soil, and grassed waterways help to control erosion.

This soil is well suited to pasture and hay. Forage yields are good, except for the wetland plants. Grazing when the soil is too wet causes surface compaction and poor tilth. The use of this soil for pasture or hay effectively controls erosion.

This soil is suitable for buildings and septic tank absorption fields. Constructing roads on well-compacted, coarse textured base material helps protect them from frost damage.

This Lindstrom soil is in capability subclass IIe.

313—Spillville loam, occasionally flooded. This nearly level, moderately well drained to somewhat poorly drained soil is in drainageways on outwash plains, end moraines, and glacial till plains. Individual areas are elongated and range from about 2 to 20 acres.

Typically, the surface layer is very dark grayish brown loam about 12 inches thick. The layers below this, to a depth of about 60 inches, are very dark brown loam in the upper part and very dark grayish brown loam in the lower part. In places the surface layer is silt loam and stratified. In other areas glacial till or sand is within a depth of 50 inches.

This Spillville soil is moderately permeable. The available water capacity is high, and runoff is slow to medium. Reaction throughout the profile ranges from neutral to medium acid. Organic matter content is high. The seasonal high water table is at a depth of 3 to 5 feet.

Most areas of this soil are cropland. This soil is well suited to this use. Corn, soybeans, and small grains are the main crops. Occasional flooding is a management concern. Wetness also delays fieldwork in the spring. Using minimum tillage, including forages in the crop rotation, and returning crop residue to the soil help to maintain tilth.

This soil is well suited to pasture and hay. Productivity of all recommended forage crops is good. Grazing early in the spring and after heavy rains should be delayed to prevent pasture damage and soil compaction. Proper stocking, rotation grazing, controlling weeds, and fertilizing are good management practices.

This soil is generally unsuitable for buildings or septic tank absorption fields because flooding is a hazard. Soils that are better suited to these uses are usually nearby. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect them from damage caused by flooding and low soil strength.

This Spillville soil is in capability subclass IIw.

317—Oshawa silty clay loam. This level, very poorly drained soil is on low flood plains of major rivers. Individual areas are irregular in shape and range from about 5 to 100 acres. This soil is subject to frequent flooding and ponding.

Typically, the surface layer is very dark gray silty clay loam about 9 inches thick. The subsurface layer is very dark gray silty clay loam about 28 inches thick, and it is mottled in the lower part. The underlying material to a depth of about 60 inches is mottled, dark gray silty clay loam.

Included with this soil in mapping are a few areas of the Minneiska soil. The moderately well drained Minneiska soil is in slightly higher positions on the flood plain than the Oshawa soil. This soil makes up about 5 to 10 percent of the map unit.

The permeability of this Oshawa soil is moderately slow. The available water capacity is high, and runoff is slow to ponded. The reaction throughout the profile is mildly alkaline to moderately alkaline. The organic matter content is high. The seasonal high water table ranges from 1 foot above the surface to 1 foot below.

Most areas of this soil are idle. This soil is well suited to wetland wildlife habitat. It provides feeding, nesting, and escape areas and can be improved for wildlife production by controlling the water level, increasing nesting and courting areas for waterfowl, and fencing out livestock.

This soil is fairly suited to pasture. Grazing when this soil is too wet causes surface compaction and destruction of pasture grasses. Proper stocking, use of moisture-tolerant grasses, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is so wet that it is generally unsuitable for crops unless properly drained. Because some areas do not have adequate drainage outlets, however, drainage may not be feasible. Frequent flooding is also a management concern.

This soil is generally unsuitable for buildings or septic tank absorption fields because flooding is a hazard. Soils that are better suited to these uses are usually nearby. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect them from damage caused by flooding and low soil strength.

This Oshawa soil is in capability subclass VIw.

318—Mayer loam, swales. This nearly level, very poorly drained soil is in swales on outwash plains and

stream terraces. Individual areas are irregular in shape and range from about 5 to 30 acres. This soil is subject to rare flooding or ponding.

Typically, the surface layer is black loam about 14 inches thick. The subsoil is about 12 inches thick. The upper part is olive silt loam, and the lower part is olive gray loam. The underlying material to a depth of about 60 inches is dark grayish brown gravelly loamy sand.

Included with this soil in mapping are small areas of the Cylinder soil. It is somewhat poorly drained and is slightly higher in position. This soil makes up 5 to 10 percent of this map unit.

This Mayer soil has moderate permeability in the upper mantle and rapid permeability in the underlying material. The available water capacity is moderate, and runoff is very slow to ponded. Reaction in the subsoil is mildly alkaline or moderately alkaline. Organic matter content is high. The seasonal high water table is within 1 foot of the surface.

Most areas of this soil are cropland. This soil is fairly suited to this use if properly drained. Corn and soybeans are the main crops. The wetness and seasonal high water table restrict root growth, cause slow soil warming in the spring, and delay fieldwork. Artificial drainage is needed to lower the water table and improve this soil for optimum crop growth. Fall plowing enables the soil to warm quicker in the spring and provides a seedbed of improved tilth; however, it increases the hazard of soil blowing.

This soil is well suited to pasture and hay, but grazing when the soil is too wet causes surface compaction and clodding. Artificial drainage and seeding of grasses and legumes that tolerate wetness improve pasture and hay production. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is generally unsuitable for buildings or septic tank absorption fields because it is subject to ponding. Soils that are better suited to these uses are usually nearby. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect them from damage caused by ponding and frost action.

This Mayer soil is in capability subclass IIIw.

320B—Tallula silt loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on side slopes and hill crests of loess-mantled uplands. Individual areas are irregular in shape and range from about 5 to 90 acres.

Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick. The subsoil is yellowish brown silt loam about 18 inches thick. The underlying material to a depth of about 60 inches is yellowish brown silt loam. In some areas the profile has no carbonates, and in other areas the surface layer is thinner and lighter colored.

Included with this soil in mapping are a few small areas of the Lindstrom soil. The well drained Lindstrom soil has a thicker surface layer and is in the upper parts of drainageways and foot slopes. This soil makes up about 5 to 10 percent of the map unit.

The permeability of this Tallula soil is moderate. The available water capacity is very high, and runoff is medium. The reaction of the subsoil is neutral to mildly alkaline. The organic matter content is moderate.

Most areas of this soil are cropland. This soil is well suited to all crops commonly grown in the area. Corn, soybeans, and small grains are the main crops. This soil is easily eroded by water. Leaving crop residue on the surface, by minimum tillage or by stubble mulching, increases infiltration and reduces runoff and erosion. Providing extra cover during seeding and early crop growth helps to control erosion. Farming on the contour reduces erosion.

This soil is well suited to pasture and hay. Including legume and grass forage in the cropping system reduces erosion, builds up nitrogen in the soil, and improves tilth for future crops. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain the most productive plants.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Constructing roads on well-compacted, coarse textured base material helps protect them from frost damage. This soil is suitable for septic tank absorption fields.

This Tallula soil is in capability subclass IIe.

320C2—Tallula silt loam, 6 to 12 percent slopes, eroded. This sloping, well drained soil is on side slopes and hill crests of loess-mantled uplands. Individual areas are irregular in shape and range from about 5 to 90 acres.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsoil is yellowish brown silt loam about 14 inches thick. The underlying material to a depth of about 60 inches is yellowish brown silt loam. In some places the surface layer is thinner and contains less clay.

Included with this soil in mapping are a few small areas of the Lindstrom soil. The well drained Lindstrom soil has a thicker surface layer and is in the upper parts of drainageways and on foot slopes. This soil makes up about 5 to 10 percent of the map unit.

The permeability of this Tallula soil is moderate. The available water capacity is very high, and runoff is rapid. The reaction of the subsoil is neutral to mildly alkaline. The organic matter content is moderate.

Most areas of this soil are cropland. This soil is well suited to this use. Corn, soybeans, and small grains are the main crops. This soil erodes easily, but keeping tillage to a minimum, farming on the contour, and

including cover crops in the cropping system reduce erosion and control runoff.

This soil is well suited to pasture and hay. Including legume and grass forage in the cropping system reduces erosion, builds up nitrogen in the soil, and improves tilth for future crops. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain the most productive plants, reduce erosion, and keep the soil in good condition.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Constructing roads on well-compacted, coarse textured base material helps protect them from frost damage. Land shaping and installing the distribution lines across the slope is generally necessary for septic tank absorption fields to function properly.

This Tallula soil is in capability subclass IIIe.

342B—Kingsley sandy loam, 3 to 8 percent slopes. This undulating to rolling, well drained soil is on hill crests and side slopes of end moraines. Individual areas are irregular in shape and range from about 3 to 40 acres.

Typically, the surface layer is black sandy loam about 8 inches thick. The subsurface layer is brown loamy sand about 4 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown and reddish brown sandy loam, and the lower part is dark brown sandy loam. The underlying material to a depth of about 60 inches is dark brown sandy loam with layers of loamy sand. In some places the underlying material contains layers of silt loam or loam.

Included with this soil in mapping are a few small areas of the Auburndale, Chetek, and Kennebec soils. The poorly drained Auburndale soil is in shallow depressions. The somewhat excessively drained Chetek soil formed in a loamy mantle and underlying sandy sediments, and it is similar in location to the Kingsley soil. The moderately well drained Kennebec soil formed in silty sediments in small depressions. These soils make up about 15 percent of the map unit.

The permeability of this Kingsley soil is moderate in the surface layer and moderately slow in the subsoil and underlying material. The available water capacity is moderate, and runoff is medium. The reaction of the subsoil ranges from slightly acid to strongly acid. The organic matter content is moderate.

Most areas of this Kingsley soil are in woodland or have been developed for housing. Some areas are cultivated and are planted to corn and small grains.

This soil has fair suitability for cultivated crops. Erosion is the main management concern. It can be controlled by minimum tillage or by including hay crops in the rotation. Contour farming also reduces erosion but is difficult on the short, irregular slopes. Stoniness hinders the use of some equipment. Droughtiness limits crop growth in some years, therefore early maturing crops are best suited to this soil.

This soil is well suited to pasture and hay. Including legume and grass forage in the cropping system reduces erosion, builds up nitrogen in the soil, and improves tilth for future crops. Droughtiness limits forage growth during dry months. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain the most productive plants.

This soil is well suited to woodland. Most trees grow well if competing vegetation is controlled.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. This soil is suitable for road construction. The moderate to moderately slow permeability restricts its use for septic tank absorption fields, but installing a larger-than-average drainage field will help to overcome this limitation.

This Kingsley soil is in capability subclass IIIe.

342C—Kingsley sandy loam, 8 to 15 percent slopes. This rolling to hilly, well drained soil is on side slopes and ridge crests of end moraines. Individual areas are irregular in shape and range from about 3 to 90 acres.

Typically, the surface layer is black sandy loam about 8 inches thick. The subsurface layer is brown loamy sand about 4 inches thick. The subsoil is about 26 inches thick. It is dark brown and reddish brown gravelly sandy loam in the upper part and grades to dark brown gravelly sandy loam. The underlying material to a depth of about 60 inches is dark brown sandy loam with layers of loamy sand. In some places the underlying material contains layers of silt loam, loam, or sand.

Included with this soil in mapping are a few areas of the Auburndale, Chetek, and Kennebec soils. The poorly drained Auburndale soil is in shallow depressions. The somewhat excessively drained Chetek soil formed in a loamy mantle and underlying sandy materials, and it is similar in location to the Kingsley soil. The moderately well drained Kennebec soil formed in silty sediments in depressions. These soils make up about 15 percent of the map unit.

The permeability of this Kingsley soil is moderate in the surface layer and moderately slow in the subsoil and underlying material. The available water capacity is moderate, and runoff is rapid. The reaction of the subsoil ranges from slightly acid to strongly acid. The organic matter content is moderate.

Most areas of this Kingsley soil are in woodland or have been developed for housing.

This soil is poorly suited to cultivated crops. Erosion is the main management concern. It can be reduced by using minimum tillage or growing hay crops. Contour farming also reduces erosion but is difficult on the short, irregular slopes. Droughtiness limits crop production in some years, therefore early maturing crops are best

suited to this soil. Stoniness hinders the use of some farm equipment.

This soil is well suited to pasture and hay. Including legume and grass forage in the cropping system reduces erosion, builds up nitrogen in the soil, and improves tilth for future crops. Droughtiness limits forage growth during dry seasons, and overgrazing causes erosion. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain the most productive plants.

This soil is well suited to woodland. Most trees grow well if competing vegetation is controlled.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads constructed on this soil should be placed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. The moderately slow permeability restricts the use of this soil for septic tank absorption fields, but installing a larger-than-average drainage field will help to overcome this limitation.

This Kingsley soil is in capability subclass IVe.

342E—Kingsley sandy loam, 15 to 25 percent slopes. This hilly to steep, well drained soil is on side slopes and narrow ridge crests of end moraines. Individual areas are irregular in shape and range from about 5 to 60 acres.

Typically, the surface layer is black sandy loam about 6 inches thick. The subsurface layer is brown loamy sand about 4 inches thick. The subsoil is dark brown and reddish brown sandy loam about 20 inches thick. The underlying material to a depth of about 60 inches is dark brown sandy loam with layers of loamy sand. In some places the underlying material contains layers of silt loam, loam, or sand.

Included with this soil in mapping are a few small areas of Chetek and Kennebec soils. The somewhat excessively drained Chetek soils formed in a loamy surface mantle and the underlying sand materials, and it is similar in location to the Kingsley soil. The moderately well drained Kennebec soil formed in silty sediments in depressions. These soils make up about 15 percent of the map unit.

The permeability of this Kingsley soil is moderate in the surface layer and moderately slow in the subsoil and underlying material. The available water capacity is moderate, and runoff is very rapid. The reaction of the subsoil ranges from slightly acid to strongly acid. The organic matter content is moderate.

Most areas of this Kingsley soil are in woodland.

This soil is generally not suited to cultivated crops because the erosion hazard is severe. Keeping it covered with vegetation minimizes runoff and erosion.

This soil has fair suitability for pasture. Droughtiness limits forage growth during dry seasons, and overgrazing causes erosion. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain the most productive plants.

The suitability of this soil for woodland is fair. Many wooded areas are especially scenic. Most trees grow well if competing vegetation is controlled. Seedling mortality is moderate. The steep slopes may cause erosion where the ground cover is damaged and may make equipment difficult to operate.

Slope is the main limitation to building on this soil. Extensive land shaping is generally needed, and buildings should be designed to conform to the natural slope of the land. Large amounts of cut and fill materials are generally needed when constructing roads on this soil. Roads should be constructed on the contour and roadbanks planted to well-adapted grasses to minimize the erosion hazard. This soil is generally unsuitable for use as septic tank absorption fields because it has steep slopes and moderately slow permeability. Soils that are better suited to this use are generally nearby.

This Kingsley soil is in capability subclass VIe.

342F—Kingsley sandy loam, 25 to 40 percent slopes. This very steep, well drained soil is on side slopes on end moraines. Individual areas are irregular in shape and range from about 3 to 40 acres.

Typically, the surface layer is black sandy loam about 3 inches thick. The subsurface layer is brown loamy sand about 4 inches thick. The subsoil is reddish brown and dark brown sandy loam about 18 inches thick. The underlying material to a depth of about 60 inches is dark brown sandy loam with layers of loamy sand. In some places the underlying material includes thin layers of silt loam, loam, or sand.

The permeability of this Kingsley soil is moderate in the surface layer and moderately slow in the subsoil and underlying material. The available water capacity is moderate, and runoff is very rapid. The reaction of the subsoil ranges from slightly acid to strongly acid. The organic matter content is moderate.

Most areas of this Kingsley soil are in woodland, and it has fair suitability for this use. Many of the wooded areas are particularly scenic. Erosion is a hazard if the ground cover is disturbed. The operation of equipment is difficult because slopes are very steep. Seedling mortality is moderate and should be a factor in tree selection. Most trees grow well if competing vegetation is controlled.

Because of the very steep slopes and severe erosion hazard, this soil is not suited to cultivated crops. This soil is poorly suited to pasture because of the very steep slopes. Overgrazing causes soil erosion, and droughtiness limits forage growth during dry seasons. Planting slopes to well adapted grasses, allowing plants to reach the proper height before grazing, and using proper rates of stocking help keep the sod in good condition and reduce the hazard of erosion.

This steep soil is generally not suitable for buildings, local roads, or septic tank absorption fields.

This Kingsley soil is in capability subclass VIIe.

344—Quam silt loam. This nearly level, very poorly drained soil is in closed depressions and around lake borders on end moraines. Individual areas are oval and range from about 3 to 20 acres.

Typically, the surface layer is very dark grayish brown silt loam about 19 inches thick. The subsoil is black silt loam about 26 inches thick. The underlying material to a depth of about 60 inches is grayish brown silt loam. In some areas of the northern third of Egan Township and Mendota Heights Township, the surface layer and subsoil contain more sand and have a loamy texture throughout. In some pedons, loam or sandy clay loam glacial till is at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of the Kennebec Variant and Palms soils. The moderately well drained Kennebec Variant soil occurs as narrow bands around the periphery of this map unit. The very poorly drained Palms soil formed in organic material and is in the center of some deep depressions. These soils make up 5 to 10 percent of the map unit.

Permeability of this Quam soil is moderate in the upper part and moderately slow in the lower part. The available water capacity is high, and runoff is slow to very slow. The reaction of the solum ranges from strongly acid to slightly acid. Organic matter content is high. The seasonal high water table ranges from 2 feet above the soil surface to 1 foot below.

Most areas of this soil are idle. This soil is well suited to wetland wildlife habitat. It provides feeding, nesting, and escape areas, but wildlife production can be improved by controlling the water level, increasing nesting and courting areas for waterfowl, and fencing out livestock.

This soil is fairly suited to pasture because it has a high water table. Grazing when the soil is too wet causes surface compaction and destruction of pasture grasses. Proper stocking, use of moisture-tolerant grasses, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to crops if properly drained. If not drained, it is generally too wet for high crop yields. Some areas do not have adequate drainage outlets; therefore, drainage may not be feasible. Ponding is also a management concern. Fall tillage enables the soil to warm quicker in the spring, but it can increase the hazard of soil blowing.

This soil is generally unsuitable for buildings or septic tank absorption fields because ponding is a hazard. Soils that are better suited to these uses are usually nearby. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect them from damage caused by ponding, frost action, and low soil strength.

This Quam soil is in capability subclass IIIw.

377B—Merton silt loam, 1 to 6 percent slopes. This gently sloping, moderately well drained to somewhat poorly drained soil is on broad foot slopes on end moraines. Individual areas are irregular in shape and range from about 3 to 60 acres.

Typically, the surface layer is black silt loam about 9 inches thick. The subsurface layer is very dark brown silt loam about 6 inches thick. The subsoil is about 35 inches thick. The upper part is dark grayish brown loam; the middle part is mottled, dark grayish brown loam; and the lower part is mottled, light olive brown loam. The underlying material to a depth of about 60 inches is mottled, light olive brown loam that contains free carbonates. In some areas the upper silty sediments are about 40 inches thick.

Included with this soil in mapping are a few small areas of the Blooming and Maxcreek soils. The Blooming soil is well drained and is in slightly elevated positions. The Maxcreek soil is poorly drained and is in slight depressions. These soils make up 3 to 8 percent of this map unit.

This Merton soil is moderately permeable. The available water capacity is high, and runoff is medium. Reaction in the subsoil ranges from medium acid through neutral. Organic matter content is high. The seasonal high water table is at a depth of 2 to 5 feet.

Most areas of this soil are cropland. This soil is well suited to this use. Corn, soybeans, and small grains are the main crops. This soil is very productive because it has a high available water capacity. The more sloping areas, however, are susceptible to erosion by water. Incorporating plant residues into the soil, using minimum tillage, or farming on the contour can reduce this problem. Wetness may delay fieldwork in the spring.

This soil is well suited to pasture and hay. Overstocking when the soil is too wet causes surface compaction and increases runoff. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

Buildings with basements should be constructed above the seasonal high water table. Tile drains around foundations remove excess subsurface water. Landscaping should be designed to drain surface water away from buildings. Constructing roads on well-compacted, coarse textured base material helps protect them from frost damage. This soil is poorly suited to septic tank absorption fields because it has a seasonal high water table. In some places, a mound-type absorption field may be suitable.

This Merton soil is in capability subclass IIe.

378—Maxfield silty clay loam. This nearly level, poorly drained soil is at the heads of drainageways on uplands. Individual areas are irregular in shape and range from about 5 to 100 acres.

Typically, the surface layer is black silty clay loam about 15 inches thick. The subsurface layer is very dark gray silty clay loam about 6 inches thick. The subsoil is about 21 inches thick. The upper part is mottled, grayish brown silty clay loam. The lower part of the subsoil and the underlying material to a depth of about 60 inches are mottled, yellowish brown loam. In some areas a silty clay loam texture extends below 42 inches.

Included with this soil in mapping are a few small areas of the Colo and Klinger soils. The Colo soil formed in alluvial sediment in depressional areas. The Klinger soil is somewhat poorly drained and is higher in position than the Maxfield soil. Each soil makes up about 5 percent of the map unit.

The permeability of this Maxfield soil is moderate. The available water capacity is very high, and runoff is slow. The reaction of the subsoil is slightly acid to neutral. The organic matter content is high. The seasonal water table is at a depth of 1 to 2 feet.

Most areas of this soil are cropland. This soil is well suited to this use if properly drained.

Corn, soybeans, and small grains are the main crops. The wetness and seasonal high water table restrict root growth, cause the soil to warm slowly in the spring, and delay fieldwork. Artificial drainage may be needed to lower the water table and improve this soil for optimum crop growth. Fall tillage enables the soil to warm quicker in the spring, and it provides a seedbed of improved tilth; however, it increases the hazard of soil blowing.

This soil is well suited to pasture and hay. Some undrained areas are in permanent pasture. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

Buildings with basements should be constructed above the seasonal high water table. Tile drains around foundations remove excess subsurface water. Landscaping should be designed to drain surface water away from buildings. Foundations and footings should be designed to prevent structure damage caused by shrinking and swelling of the soil. Backfilling around foundations with suitable coarse material provides added protection against structure damage. Constructing roads on well-compacted, coarse textured base material helps to protect them from damage caused by frost action, low soil strength, and shrinking and swelling of the soil. This soil is poorly suited to septic tank absorption fields because it has a seasonal high water table. In some areas, a mound-type absorption field may be suitable.

This Maxfield soil is in capability subclass IIw.

382B—Blooming silt loam, 1 to 6 percent slopes. This gently sloping, well drained soil is on summits and side slopes of end moraines. Individual areas are irregular in shape and range from about 5 to 40 acres.

Typically, the surface layer is very dark brown silt loam about 9 inches thick. The subsoil is about 39 inches thick. The upper part is dark brown silty clay loam that grades to dark yellowish brown and yellowish brown sandy clay loam in the lower part. The underlying material to a depth of about 60 inches is calcareous, light olive brown fine sandy loam. In some areas the upper loamy sediments are as much as 40 inches thick. As much as 12 inches of sand and gravel is between the upper loamy sediments and the underlying till in some areas. In some areas mapped in association with the Kingsley-Lester complex, this soil is underlain by leached, dark brown sandy loam.

Included with this soil in mapping are a few small areas of the Merton soils. The Merton soil is moderately well drained to somewhat poorly drained and is in shallow depressions, drainageways, and less sloping areas. This soil makes up 5 to 10 percent of the map unit.

This Blooming soil has moderate permeability. The available water capacity is high, and runoff is medium. The reaction of the subsoil is slightly acid to medium acid. The organic matter content is high.

Most areas of this soil are cropland or pasture. This soil is well suited to these uses. Corn, soybeans, and small grains are the main crops. This soil is easily eroded by water, but erosion can be reduced by incorporating plant residues into the soil, using minimum tillage, or farming on the contour. It is well suited to pasture and hay. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods reduce surface compaction and maintain good grazing conditions.

This soil is well suited to trees. Seedling mortality, equipment limitations, and the erosion hazard are slight. Plant competition is severe. Seedlings and cuttings survive and grow well if competing vegetation is controlled.

If buildings are constructed on this soil, foundations and footings should be designed to prevent structure damage caused by shrinking and swelling of the soil. Backfilling around foundations with suitable coarse material provides added protection against structure damage. Constructing roads on well-compacted, coarse textured base material will help to protect them from damage caused by low soil strength and frost action. This soil is suitable for septic tank absorption fields.

This Blooming soil is in capability subclass IIe.

408—Faxon silty clay loam. This nearly level, poorly drained and very poorly drained soil is on bedrock-controlled terraces along flood plains of major rivers. Individual areas are irregular in shape and range from about 5 to 20 acres. This soil is subject to frequent flooding.

Typically, the surface layer is very dark gray silty clay loam about 12 inches thick. The subsurface layer is very

dark gray and black silty clay, clay, and clay loam about 16 inches thick. The underlying material is grayish brown flaggy loam and light gray flaggy silt loam about 9 inches thick. The underlying material is limestone bedrock. In some areas all or part of the solum is organic material. In other areas there are limestone outcrops.

Included with this soil in mapping are a few small areas of the Oshawa and Seelyeville soils. Both of these soils are deep to bedrock, and the Seelyeville soil is made up completely of organic material. These soils are similar in position to the Faxon soil. They make up 2 to 10 percent of this map unit.

This Faxon soil is moderately permeable. The available water capacity is moderate, and runoff is slow. Reaction throughout the profile ranges from neutral to moderately alkaline. Organic matter content is moderate to high. The root zone is 20 to 40 inches deep. Depth to the seasonal high water table is 0 to 1 foot.

Most areas of this soil are idle. It is fairly suited to wetland wildlife habitat. The shallow depth to bedrock limits the use of this soil for excavated ponds.

This soil is generally not suited to cultivated crops because of wetness and the frequent flooding hazard. Improving drainage on this soil is difficult because it is shallow to bedrock. This soil is fairly suited to pasture. Soil wetness and frequent flooding are the main management concerns. Proper stocking, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is generally unsuitable for buildings or septic tank absorption fields because flooding is a hazard. Soils that are better suited to these uses are usually nearby. Constructing roads on raised, well-compacted fill material and providing adequate side ditches and culverts help protect them from flood and frost damage.

This Faxon soil is in capability subclass VIw.

409B—Etter fine sandy loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on convex crests and side slopes of uplands. Individual areas are irregular in shape and range from about 5 to 80 acres.

Typically, the surface layer is very dark grayish brown fine sandy loam about 15 inches thick. The subsoil is dark brown fine sandy loam about 6 inches thick. The underlying material to a depth of about 60 inches is brownish yellow and yellow fine sand. In some areas there is no dark colored surface layer. Some areas do not have fine sand within 40 inches of the surface. In other areas the surface layer is up to 60 percent coarse fragments, mostly limestone.

Included with this soil in mapping are small areas of the Wadena soil and similar soils that have a finer texture in the surface layer and subsoil. These soils are similar in position to the Etter soils. They make up 2 to 10 percent of the map unit.

Permeability of this Etter soil is moderate in the upper part and rapid in the underlying material. The available water capacity is moderate, and runoff is slow. Reaction in the subsoil is strongly acid to neutral. Organic matter content is moderate. The lower depth of the root zone is 20 to 40 inches.

Most areas of this soil are cropland. This soil is fairly suited to this use. Corn, soybeans, and small grains are the main crops. Droughtiness is the main limitation to the use of this soil for crops. Early maturing crops, such as small grains, are best suited to this soil. This soil is suited to irrigation. Using minimum tillage, maintaining a good cover crop, and returning crop residues to the soil help to conserve available moisture and to control erosion.

This soil is fairly suited to pasture and hay. Droughtiness is the main management concern. This soil provides fair pasture in the spring but yields little forage during the dry summer. Planting drought-resistant forage plants, proper stocking, rotation grazing, fertilizing, and controlling weeds help keep the soil and pasture in good condition. Also, the use of this soil for pasture and hay effectively controls erosion.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. This soil is suitable for road construction. It readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Etter soil is in capability subclass IIIs.

409C—Etter fine sandy loam, 6 to 12 percent slopes. This sloping, well drained soil is on convex crests and side slopes of uplands. Individual areas are irregular in shape and range from 5 to 40 acres.

Typically, the surface layer is very dark grayish brown fine sandy loam about 13 inches thick. The subsoil is dark brown fine sandy loam about 7 inches thick. The underlying material to a depth of about 60 inches is brownish yellow or very pale brown fine sand. Some areas do not have a dark colored surface layer. Some areas do not have fine sand within 40 inches. Also, in some areas the surface layer contains up to 60 percent coarse fragments, mostly limestone.

Included with this soil in mapping are small areas of the Wadena soil and similar soils that are finer textured in the surface layer and subsoil. These soils are similar in position to the Etter soil. They make up 2 to 8 percent of the map unit.

Permeability of this Etter soil is moderate in the upper part and rapid in the underlying material. The available water capacity is moderate, and runoff is medium. Reaction in the subsoil is strongly acid to neutral.

Organic matter content is moderate. The lower depth of the root zone is 20 to 40 inches.

Most areas of this soil are cropland. This soil is poorly suited to this use. Erosion and droughtiness are the main management concerns. Using minimum tillage, farming on the contour, maintaining a good cover crop, and returning crop residues to the soil help to conserve the available moisture and to control erosion. Terracing, where possible, is also a good erosion-control measure. Early maturing crops, such as small grains, are best suited to this soil. They also help control erosion. This soil is suited to irrigation. This, in turn, increases the hazard of erosion.

This soil is poorly suited to pasture and hay. Droughtiness and the hazard of erosion are the main management concerns. This soil provides fair pasture in the spring, but yields little forage during the dry summer. Planting drought-resistant forage plants, proper stocking, rotation grazing, fertilizing, and controlling weeds help keep the soil and pasture in good condition. Also, the use of this soil for pasture and hay effectively controls erosion.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Etter soil is in capability subclass IVe.

411A—Waukegan silt loam, 0 to 1 percent slopes. This level, well drained soil is on loamy, mantled outwash plains and stream terraces. Individual areas are irregular in shape and range from about 5 to 200 acres (fig. 10).

Typically, the surface layer is very dark brown silt loam about 8 inches thick. The subsurface layer is very dark grayish brown silt loam about 5 inches thick. The subsoil is about 29 inches thick. The upper part is dark brown and dark yellowish brown silt loam. The lower part is dark yellowish brown sandy loam and gravelly coarse sand. The underlying material to a depth of about 60

Figure 10.—Nursery farm in an area of Waukegan silt loam, 0 to 1 percent slopes.

inches is yellowish brown gravelly sand. In some places, loam textures occur in the upper sediments. When mapped in association with the Boone and Etter soils, the underlying material may be partially made up of weathered or eroded sandstone bedrock. Some areas have noncalcareous, reddish colored sand and gravelly sand in the underlying material.

Included with this soil in mapping are small areas of the Estherville and Kanaranzi soils. The Estherville soil is somewhat excessively drained and is slightly higher in position than the Waukegan soil. The Kanaranzi soil has a thinner solum and is similar in position to the Waukegan soil. These soils make up 5 to 15 percent of this map unit.

Permeability of this Waukegan soil is moderate in the silty mantle and rapid in the sandy underlying material. The available water capacity is moderate, and runoff is very slow. Reaction in the subsoil ranges from strongly acid to neutral. Organic matter content is high. The seasonal high water table is below a depth of 6 feet.

Most areas of this soil are cropland. This soil is well suited to crops commonly grown in the area. Corn, soybeans, and small grains are the main crops. The moderate available water capacity is the main management concern; droughtiness occurs during dry periods. Using minimum tillage, returning crop residue to the soil, and including forage crops in the rotation improve the retention of water in the soil. This soil is well suited to irrigation.

This soil is well suited to pasture and hay. Droughtiness occasionally limits production during dry years. Proper stocking, rotation grazing, fertilizing, and controlling weeds help to maintain a good cover of the more desirable grasses.

This soil is suitable for buildings. Constructing roads on well-compacted, coarse textured base material helps protect them from damage caused by low soil strength. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of groundwater supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Waukegan soil is in capability subclass IIs.

411B—Waukegan silt loam, 1 to 6 percent slopes. This gently sloping, well drained soil is on loamy mantled outwash plains and stream terraces. Individual areas are irregular in shape and range from about 5 to 150 acres.

Typically, the surface and subsurface layers are silt loam and, combined, are about 12 inches thick. The surface layer is very dark brown, and the subsurface layer is very dark grayish brown. The subsoil is about 27 inches thick. The upper part is dark brown and dark yellowish brown silt loam, and the lower part is dark yellowish brown sandy loam and gravelly coarse sand. The underlying material to a depth of about 60 inches is yellowish brown gravelly sand. In some places loam textures occur in the upper sediments. When mapped in association with the Boone and Etter soils, the underlying material may be partially made up of weathered or eroded sandstone bedrock. Some areas have noncalcareous, reddish colored sand and gravelly sand in the underlying material.

Included with this soil in mapping are small areas of the Estherville and Kanaranzi soils. The Estherville soil is excessively drained and is slightly higher in position than the Waukegan soil. The Kanaranzi soil has a thinner solum and is similar in position to the Waukegan soils. These soils make up 5 to 15 percent of this map unit.

Permeability of this Waukegan soil is moderate in the silty mantle and rapid in the sandy underlying material. The available water capacity is moderate, and runoff is medium. Reaction in the subsoil ranges from strongly acid to neutral. Organic matter content is high.

Most areas of this soil are cropland. This soil is well suited to crops commonly grown in the area. Corn, soybeans, and small grains are the main crops. The hazard of erosion and moderate available water capacity are the main management concerns. Using minimum tillage, returning crop residue to the soil, and including forage in the rotation reduce erosion and help to conserve moisture. This soil is well suited to irrigation.

This soil is well suited to pasture and hay. Droughtiness limits production during dry years. Proper stocking, rotation grazing, fertilizing, and controlling weeds help to maintain a good cover of the more desirable grasses and reduce erosion.

This soil is suitable for buildings. Constructing roads on well-compacted, coarse textured base material helps protect them from damage caused by low soil strength. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of groundwater supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Waukegan soil is in capability subclass IIe.

411C—Waukegan silt loam, 6 to 12 percent slopes. This sloping, well drained soil is on loamy mantled outwash plains and stream terraces. Individual areas are irregular in shape and range from about 5 to 20 acres.

Typically, the surface and subsurface layers are silt loam and, combined, are about 12 inches thick. The surface layer is brown, and the subsurface layer is very dark grayish brown. The subsoil is about 20 inches thick. The upper part is dark brown or dark yellowish brown silt loam, and the lower part is dark yellowish brown sandy loam and gravelly coarse sand. The underlying material to a depth of about 60 inches is yellowish brown gravelly sand. In a few places loam textures occur in the upper

mantle. Also, in some areas the solum is thinner. When mapped in association with the Boone and Etter soils, the underlying material may be partially made up of weathered or eroded sandstone bedrock. Some areas have noncalcareous, reddish colored sand and gravelly sand in the underlying material.

Included with this soil in mapping are small areas of the Kanaranzi soil. It has a thinner solum and is similar in position to the Waukegan soils. This soil makes up 5 to 10 percent of this map unit.

Permeability of this Waukegan soil is moderate in the silty mantle and rapid in the sandy underlying material. The available water capacity is moderate, and surface runoff is rapid. Reaction in the subsoil ranges from strongly acid to neutral. Organic matter content is high.

Most areas of this soil are cropland. This soil is well suited to crops commonly grown in the area. Corn, soybeans, and small grains are the main crops. The hazard of erosion and moderate available water capacity are the main management concerns. Minimum tillage, no-till planting, cover crops, and field windbreaks reduce erosion and help to conserve moisture. Terracing is also a good erosion control measure. Early maturing crops are best suited to this soil. This soil is well suited to irrigation; however, erosion control is needed to keep the soil loss within acceptable limits.

This soil is well suited to pasture and hay. This soil provides good pasture in the spring and fall, but during the summer supplemental pastures may be needed to insure adequate production. Proper stocking, rotation grazing, fertilizing, and controlling weeds help to maintain a good cover of the more desirable grasses and reduce erosion. Keeping these areas under continuous cover reduces erosion.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Constructing roads on well-compacted, coarse textured base material helps protect them from damage caused by low soil strength. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines as close to the surface as possible. In some areas, additional precautionary measures may be necessary.

This Waukegan soil is in capability subclass IIIe.

414—Hamel silt loam. This nearly level, poorly drained soil is in swales, on foot slopes, and in the upper reaches of drainageways on end moraines. Individual areas are irregular in shape and range from about 2 to 30 acres.

Typically, the surface layer is black silt loam about 16 inches thick. The subsoil is about 24 inches thick. The upper part is very dark gray silty clay loam; the middle part is mottled, very dark grayish brown silty clay loam; and the lower part is mottled, dark grayish brown loam. The underlying material to a depth of about 60 inches is mottled, olive brown loam. In some areas the black or very dark colors are thinner than 24 inches. In a few places the subsoil has no clay films.

Included with this soil in mapping are a few small areas of the Le Sueur and Glencoe soils. The Le Sueur soil is moderately well drained to somewhat poorly drained and is slightly higher than the Hamel soil. The Glencoe soil is very poorly drained and in the lower parts of swales and in drainageways along the watercourse. These soils make up about 3 to 10 percent of this map unit.

This Hamel soil has moderately slow permeability. The available water capacity is high, and runoff is slow. Reaction in the subsoil ranges from neutral to medium acid. Organic matter content is high. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas of this soil are cropland. This soil is well suited to this use. Corn and soybeans are the main crops. The wetness and seasonal high water table restrict root growth, cause the soil to warm slowly in the spring, and delay fieldwork. Artificial drainage is needed to lower the water table and improve this soil for optimum crop growth. Fall tillage enables the soil to warm quicker in the spring and provides a seedbed of improved tilth; however, it can increase the hazard of soil blowing.

This soil is well suited to pasture and hay. It holds moisture well throughout the growing season. Some undrained areas are in permanent pasture. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is fairly suited to woodland. Seedlings may not survive unless competing vegetation is controlled. Wetness may make equipment operation difficult.

This soil is poorly suited to buildings because it is wet. If buildings are constructed on this soil, they should be built without basements and the landscaping should be designed to drain surface water away from buildings. Tile drains around foundations remove excess subsurface water. Constructing roads on well-compacted, coarse textured fill material helps to protect them from damage caused by low soil strength and frost action. This soil is poorly suited to septic tank absorption fields because it has a seasonal high water table and moderately slow permeability. In some places a mound-type absorption field may be suitable

This Hamel soil is in capability subclass IIw.

415A—Kanaranzi loam, 0 to 2 percent slopes. This nearly level, well drained or somewhat excessively drained soil is on loamy mantled outwash plains.

Individual areas are irregular in shape and range from about 10 to 50 acres.

Typically, the surface layer is very dark grayish brown loam about 9 inches thick. The subsoil is about 14 inches thick. The upper part is dark yellowish brown silt loam, and the lower part is dark yellowish brown loamy sand. The underlying material to a depth of about 60 inches is brown coarse sand (fig. 11). In some areas the surface layer and subsoil are thicker.

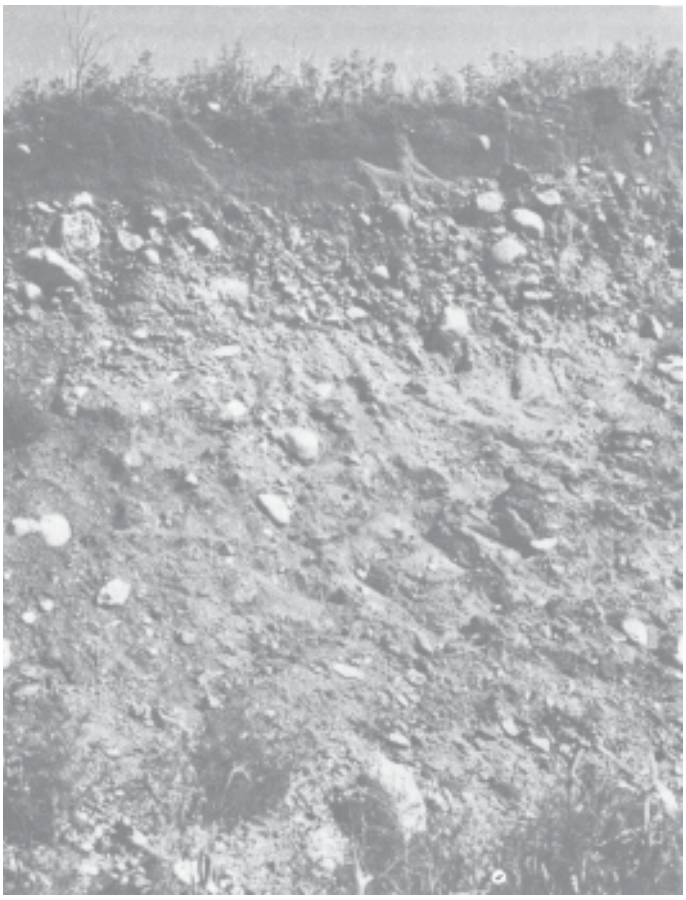


Figure 11.—Profile of Kanaranzi loam, 0 to 2 percent slopes.

This Kanaranzi soil has moderate permeability in the loamy mantle and rapid permeability in the underlying material. The available water capacity is low, and runoff is slow. Reaction in the subsoil is medium acid to mildly alkaline. Organic matter content is high.

Most areas of this soil are cropland. This soil is fairly suited to crops commonly grown in the area. Corn, soybeans, and small grains are the main crops. Droughtiness is the main management concern. Early maturing crops are best suited to this soil. Using minimum tillage, returning crop residue to the soil, and including forage in the rotation help to retain the limited soil moisture. This soil is well suited to irrigation; however, frequent applications are needed because the available water capacity is low.

This soil is fairly suited to pasture and hay. This soil provides fair pasture in the spring and fall, but during the summer supplemental pastures may be needed to insure adequate production. Proper stocking, rotation grazing, fertilizing, and controlling weeds help maintain a good cover of the more desirable grasses. Where planting is necessary to improve stands, more drought-resistant plants are needed.

This soil is suitable for buildings. Constructing roads on well-compacted, coarse textured base material helps protect them from frost damage. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Kanaranzi soil is in capability subclass IIIs.

415B—Kanaranzi loam, 2 to 6 percent slopes. This gently sloping, well drained or somewhat excessively drained soil is on loamy mantled outwash plains. Individual areas are irregular in shape and range from about 10 to 30 acres.

Typically, the surface layer is very dark grayish brown loam about 9 inches thick. The subsoil is about 13 inches thick. The upper part is dark yellowish brown silt loam, and the lower part is dark yellowish brown loamy sand. The underlying material to a depth of about 60 inches is brown coarse sand. In some areas the surface layer and subsoil are thicker.

This Kanaranzi soil has moderate permeability in the loamy mantle and rapid permeabilty in the underlying material. The available water capacity is low, and runoff is medium. Reaction in the subsoil is medium acid to mildly alkaline. Organic matter content is high.

Most areas of this soil are cropland. This soil is fairly suited to crops commonly grown in the area. Corn, soybeans, and small grains are the main crops. Erosion is the main management concern. Minimum tillage, no-till planting, cover crops, and field windbreaks reduce erosion and help to conserve moisture. Early maturing crops are best suited to this soil. It is well suited to irrigation; however, frequent applications are needed because it has a low available water capacity and rapid permeability in the underlying material.

This soil has fair suitability for pasture and hay. It provides fair pasture in the spring and fall, but during the summer supplemental pastures may be needed to insure adequate production. Proper stocking, rotation grazing, fertilizing, and controlling weeds help maintain a good cover of the more desirable grasses and reduce erosion. Where planting is necessary to improve stands, more

drought-resistant plants are needed. Keeping these areas under continuous cover reduces erosion.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Constructing roads on well-compacted, coarse textured base material helps protect them from frost damage. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Kanaranzi soil is in capability subclass IIIe.

415C—Kanaranzi loam, 6 to 12 percent slopes. This sloping, well drained or somewhat excessively drained soil is on loamy mantled outwash plains. Individual areas are irregular in shape and range from about 10 to 20 acres.

Typically, the surface layer is very dark grayish brown loam about 9 inches thick. The subsoil is about 10 inches thick. The upper part is dark yellowish brown silt loam, and the lower part is dark yellowish brown loamy sand. The underlying material to a depth of about 60 inches is brown coarse sand. In some areas the surface layer and subsoil are thicker.

This Kanaranzi soil has moderate permeability in the loamy mantle and rapid permeability in the underlying material. The available water capacity is low, and runoff is rapid. Reaction in the subsoil is medium acid to mildly alkaline. Organic matter content is high.

Most areas of this soil are cropland. This soil is fairly suited to crops commonly grown in the area because of the hazard of erosion and low available water capacity. Minimum tillage, no-till planting, cover crops, and field windbreaks reduce erosion and help to conserve moisture. Early maturing crops are best suited to this soil. It is suited to irrigation; however, frequent applications are needed because it has low available water capacity and rapid permeability in the underlying material.

This soil is fairly suited to pasture and hay. This soil provides fair pasture in the spring and fall, but during the summer supplemental pastures may be needed to insure adequate production. Proper stocking, rotation grazing, fertilizing, and controlling weeds help maintain a good cover of the more desirable grasses and reduce erosion. Where planting is necessary to improve stands, more drought-resistant plants are needed. Keeping these areas under continuous cover reduces erosion.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. Constructing roads on well-compacted, coarse textured base material helps protect them from frost damage. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Kanaranzi soil is in capability subclass IVe.

449B—Crystal Lake silt loam, 1 to 8 percent slopes. This gently sloping to sloping, moderately well drained soil is on convex side slopes on end moraines. Individual areas range from about 5 to 30 acres and are irregular in shape.

Typically, the surface layer is dark grayish brown silt loam about 9 inches thick. The subsoil is about 31 inches thick. The upper part is dark brown silt loam and silty clay loam, and the lower part is mottled, dark yellowish brown silty clay loam. The underlying material to a depth of about 60 inches is mottled brown silty clay loam. In some areas the subsoil does not have mottles. Some areas have carbonates or sandy layers in the underlying material.

The permeability of this Crystal Lake soil is moderate. The available water capacity is very high, and runoff is slow to medium. The reaction of the subsoil is strongly acid to slightly acid. The organic matter content is low or moderately low. The seasonal high water table ranges in depth from 2.5 to 6 feet.

This soil is well suited to cultivated crops. Erosion is the main management concern. Erosion can be controlled by using minimum tillage, by including hay crops in the rotation, or by returning crop residues to the soil. Contour farming is difficult in some areas because slopes are irregular. Trafficability is poor during wet periods because the surface texture is silty.

This soil is well suited to pasture and hay. The use of legume and grass forage in the cropping system reduces erosion, builds up nitrogen in the soil, and improves tilth for future crops. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain the most productive plants.

This soil is well suited to woodland. Most trees grow well if competing vegetation is controlled.

Buildings with basements should be constructed above the seasonal high water table. Tile drains around foundations remove excess subsurface water. Foundations and footings should be designed to prevent structure damage caused by shrinking and swelling of the soil. Buildings should be designed to conform to the natural slope of the land. Constructing roads on well-compacted, coarse textured base material helps to protect them from damage caused by low soil strength and frost action. This soil is poorly suited to septic tank absorption fields because it has a seasonal high water

table. In some areas, a mound-type absorption field may be suitable.

This Crystal Lake soil is in capability subclass IIe.

454B—Mahtomedi loamy sand, 3 to 8 percent slopes. This undulating to rolling, excessively drained soil is on end moraines and pitted outwash plains. Individual areas are irregular in shape and range from about 3 to 50 acres.

Typically, the surface layer is very dark grayish brown loamy sand about 7 inches thick. The subsoil is dark brown and dark yellowish brown gravelly coarse sand and coarse sand about 35 inches thick. The underlying material to a depth of about 60 inches is yellowish brown stratified sand and gravelly coarse sand.

Included with this soil in mapping are a few small areas of the Kingsley soil. It formed in sandy loam glacial till. The Kingsley soil is similar in position to the Mahtomedi soil. This soil makes up about 15 percent of the map unit.

Permeability of this Mahtomedi soil is rapid. The available water capacity is low, and runoff is slow. Reaction in the subsoil ranges from slightly acid to strongly acid. Organic matter content is low. Depth to the seasonal high water table is more than 6 feet.

This soil is poorly suited to most cultivated crops because it has a low available water capacity. Droughtiness limits crop production in most years. Early maturing crops are best suited to this soil. Using minimum tillage, returning crop residue to the soil, and including forage in the rotation improve the available water capacity and reduce erosion.

This soil has fair suitability for pasture and hay. Productivity is generally low and supplemental pastures may be needed to insure adequate yields. Proper stocking, rotation grazing, fertilizing, and controlling weeds help maintain a good cover of the more desirable grasses. Where planting is necessary to improve stands, more drought-resistant plants are needed.

This soil is fairly suited to woodland. Because it is droughty, seedling mortality is severe and many trees grow poorly.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. This soil is suitable for road construction. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Mahtomedi soil is in capability subclass IVs.

454C—Mahtomedi loamy sand, 8 to 15 percent slopes. This rolling to hilly, excessively drained soil is on end moraines and pitted outwash plains. Individual areas are irregular in shape and range from about 3 to 90 acres.

Typically, the surface layer is very dark grayish brown loamy sand about 5 inches thick. The subsoil is dark brown and dark yellowish brown gravelly coarse sand and coarse sand about 30 inches thick. The underlying material to a depth of about 60 inches is yellowish brown stratified sand and gravelly coarse sand.

Included with this soil in mapping are a few small areas of the Kingsley soil. It formed in sandy loam glacial till. The Kingsley soil is similar in position to the Mahtomedi soil. This soil makes up about 15 percent of the map unit.

This Mahtomedi soil is rapidly permeable. The available water capacity is low, and runoff is medium. The reaction of the subsoil ranges from slightly acid to strongly acid. Organic matter content is low.

This soil is generally unsuitable for most cultivated crops because it has a low available water capacity. Droughtiness limits crop production in most years.

This soil has fair suitability for pasture and hay. Productivity is usually low, and supplemental pastures may be needed to insure adequate yields. Proper stocking, rotation grazing, fertilizing, and controlling weeds help to maintain a good cover of the more desirable grasses. Where planting is necessary to improve stands, more drought-resistant plants are needed.

This soil is fairly suited to woodland. Because it is droughty, seedling mortality is severe and many trees grow poorly. Steep slopes limit the use of machinery. Areas of these soils used for woodland wildlife should be managed to protect existing habitat and to maintain or improve its quality.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface.

This Mahtomedi soil is in capability subclass VIs.

454E—Mahtomedi loamy sand, 15 to 25 percent slopes. This hilly to steep, excessively drained soil is on pitted outwash plains and end moraines. Individual areas are irregular in shape and range from about 3 to 40 acres.

Typically, the surface layer is very dark grayish brown loamy sand about 4 inches thick. The subsoil is dark brown and dark yellowish brown gravelly coarse sand and coarse sand about 28 inches thick. The underlying

material to a depth of about 60 inches is yellowish brown stratified sand and gravelly coarse sand.

Included with this soil in mapping are a few small areas of the Kennebec and Kingsley soils. The Kingsley soil formed in sandy loam glacial till. It is similar in position to the Mahtomedi soil. The Kennebec soil formed in silty colluvium in depressions. These soils make up about 15 percent of the map unit.

This Mahtomedi soil has rapid permeability. The available water capacity is low, and runoff is rapid. The reaction of the subsoil is slightly acid to strongly acid. Organic matter content is low.

This soil is generally unsuitable for cultivated crops. Droughtiness limits crop production in most years. The hazard of erosion is severe, and the steep slopes limit the use of farm equipment on this soil. Keeping it covered with vegetation minimizes runoff and erosion.

This soil is fairly suited to pasture. Droughtiness frequently limits forage growth, and supplemental pasture may be needed to insure adequate yields. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain the most productive plants and to keep the pasture in good condition.

This soil is poorly suited to woodland. Droughtiness is the main management concern. Seedling mortality is severe.

Slope is the main limitation for buildings. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope of the land. Large amounts of cut and fill materials are usually needed when constructing roads on this soil. Roads should be constructed on the contour and roadbanks planted to well-adapted grasses to minimize the erosion hazard. This soil is poorly suited to septic tank absorption fields because it has poor filtering ability and is hilly to steep. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface and placing them across the slope. Additional precautionary measures may be necessary to overcome the pollution hazard.

This Mahtomedi soil is in capability subclass VIs.

463—Minneiska loam, occasionally flooded. This nearly level, moderately well drained soil is on flood plains of major rivers. Individual areas are commonly elongated and range from about 10 to 150 acres (fig. 12).

Typically, the surface layer is about 8 inches thick. It is very dark grayish brown, dark brown, and brown loam with thin layers of silt loam and very fine sandy loam. The underlying material to a depth of about 60 inches is dark grayish brown loam and loamy fine sand with strata of fine sandy loam and silt loam. In some areas the solum does not have prominent stratification.

Included with this soil in mapping along the Minnesota River flood plain are a few areas of the very poorly drained Oshawa soil. It is in narrow bands around the periphery of this map unit. This soil makes up 5 to 10 percent of the unit. When mapped along the Mississippi River, a few areas of the poorly drained Colo soil is also included in this map unit. This soil has no stratification and is in adjacent flood plain areas. The Colo soil makes up 5 to 10 percent of the unit.

The permeability of this Minneiska soil is moderately rapid. The available water capacity is very high, and runoff is slow. The subsoil is mildly alkaline to moderately alkaline. The organic matter content is moderate. Depth to a seasonal high water table is 3 to 6 feet.

This soil is well suited to crops. Most areas of this soil are cropland or are idle. Corn, soybeans, and small grains are the main crops. The occasional flooding hazard is a management concern because it may damage crops. Wetness may also delay fieldwork in the spring. Using minimum tillage, including forages in the cropping rotation, and returning crop residue to the soil help to maintain tilth.

This soil is well suited to pasture and hay. Productivity is good for all recommended forage crops. Grazing early in the spring and after heavy rains causes pasture damage and soil compaction. Proper stocking, rotation grazing, controlling weeds, and fertilizing are good management practices.

This soil is well suited to woodland. Most trees grow well if competing vegetation is controlled.

This soil is generally unsuitable for buildings or septic tank absorption fields because of the flooding hazard. Soils that are better suited to these uses are usually nearby. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect them from damage caused by flooding.

This Minneiska soil is in capability subclass IIw.

465—Kalmarville sandy loam, frequently flooded. This level, poorly drained to very poorly drained soil is on low flood plains of rivers. Individual areas are elongated and parallel to adjoining rivers and range from about 5 to 40 acres.

Typically, the surface layer is about 42 inches deep. It is black sandy loam stratified with multicolored loam and loamy fine sand. The underlying material to a depth of about 60 inches is dark grayish brown stratified sand that has multicolored strata of loamy sand and coarse sand. In some areas the underlying sands are nearer to the surface. In some areas the surface layer is dark colored and is not stratified.

Permeability of this Kalmarville soil is moderately rapid in the upper sediments and rapid in the underlying sand. The available water capacity is moderate, and runoff is slow. Reaction ranges from neutral to mildly alkaline.

Figure 12.—Area of flooded Minneiska loam during spring snowmelt runoff. The Hubbard soils in the foreground do not flood.

The organic matter content is high. The seasonal high water table is 0 to 1 foot below the soil surface.

Most areas of this soil are idle or are used for pasture. This soil has fair suitability for pasture. Wetness and frequent flooding are the main management concerns. Production of pasture grasses is low during the dry summer. Proper stocking, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is poorly suited to crops. Floods frequently damage crops, and wetness delays fieldwork. During the summer this soil is somewhat droughty.

This soil is suited to trees; however, the use of planting and harvesting equipment is limited when this soil is wet. Plant competition is severe. Controlling weeds, cultivating, and applying herbicide help control competing plants.

This soil is generally unsuitable for buildings or septic tank absorption fields because it is frequently flooded. Soils that are better suited to these uses are usually nearby. Constructing roads on raised, well-compacted fill material and providing adequate side ditches and culverts help protect them from flood and frost damage.

This Kalmarville soil is in capability subclass Vw.

495—Zumbro fine sandy loam. This nearly level, well drained and moderately well drained soil is on the high bottoms of flood plains and along drainageways on outwash plains. Individual areas are elongated and range from about 5 to 30 acres. This soil is subject to rare flooding.

Typically, the surface layer is black fine sandy loam about 18 inches thick. The subsurface layer is very dark gray loamy fine sand about 38 inches thick. The subsoil to a depth of about 60 inches is dark brown fine sand. In some places sandy loam, silt loam, and loam textures are within a depth of 40 inches.

Permeability of this Zumbro soil is rapid. The available water capacity is low, and runoff is slow. The reaction of

the subsoil is slightly acid through mildly alkaline. Organic matter content is moderate.

Most areas of this soil are cropland. This soil is fairly suited to crops commonly grown in the area. Corn, soybeans, and small grains are the main crops. Because the available water capacity is low, early maturing crops are best suited to this soil. Soil blowing is a problem and easily damages young plants. Minimum tillage, no-till planting, cover crops, and field windbreaks reduce soil blowing and conserve moisture.

This soil is fairly suited to pasture and hay. It provides fair pasture in the spring and fall, but during the summer supplemental pastures may be needed to insure adequate production. Proper stocking, rotation grazing, fertilizing, and controlling weeds help maintain a good cover of the more desirable grasses and reduce erosion.

This soil is generally unsuitable for buildings or septic tank absorption fields because of the flooding hazard. Soils that are better suited to these uses are usually nearby. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect them from damage caused by flooding.

This Zumbro soil is in capability subclass IIIs.

522—Boots muck. This nearly level, very poorly drained soil is in broad areas of the Minnesota River flood plain and in depressions on end moraines. It is subject to flooding or ponding. Individual areas are irregular in shape and range from about 5 to 50 acres.

Typically, the surface layer is black muck about 5 inches thick. The middle layer is very dark grayish brown peaty muck about 21 inches thick. The underlying material to a depth of about 60 inches is very dark grayish brown peaty muck. In some places sandy or silty materials are within 51 inches of the surface. When mapped on moraines, this soil may not have carbonates and may be medium acid.

Permeability of this Boots muck is moderate. The available water capacity is very high, and runoff is very slow to ponded. The reaction is neutral or mildly alkaline. Organic matter content is very high. The seasonal high water table is within 1 foot of the surface.

Most areas of this soil are left idle. This soil is well suited to wetland wildlife habitat, and suitable water habitat is easy to develop. Wetland food and cover crops grow well on this soil.

This soil is well suited to crops if artificially drained. Corn and soybeans are the main crops. Before draining bogs, a thorough investigation to determine the thickness of the muck deposits is needed. The muck layer tends to subside after drainage and become thin after intensive cropping. This soil is subject to soil blowing if row crops are grown.

Undrained areas are fairly suited to pasture if well managed. This soil is well suited to reed canarygrass because it forms a tough, dense sod that can support grazing animals and haying equipment even though the soil is partly wet.

This soil is generally unsuitable for buildings and septic tank absorption fields because flooding is a hazard, and structure damage may result because the soil strength is low. Soils that are better suited to these uses are usually nearby. Constructing roads on raised, well-compacted fill material and providing adequate side ditches and culverts help protect them from flood and frost damage.

This Boots soil is in capability subclass IIIw.

539—Palms muck. This nearly level, very poorly drained soil is in upland depressions and on the Minnesota River flood plain. It is subject to frequent flooding or ponding. Individual areas are irregular in shape and range from about 5 to 40 acres.

Typically, the surface layer is black muck about 38 inches thick. The middle layer is black muck about 7 inches thick. The underlying mineral material to a depth of about 60 inches is black clay loam and mottled, dark gray clay loam. In some areas the muck is more than 50 inches thick over the underlying mineral soil, and in other areas the muck is shallower than 16 inches.

This Palms soil has moderate to moderately slow permeability. The available water capacity is very high, and runoff is very slow to ponded. Reaction in the organic material ranges from strongly acid to mildly alkaline. Organic matter content is very high. The seasonal high water table is within 1 foot of the surface.

Most areas of this soil are left idle. Although some areas are in permanent pasture or crops, pastures on this soil tend to be very brushy and provide poor grazing. These areas can sometimes be cleared, drained, and seeded to moisture-tolerant, more productive grasses. Proper stocking, use of moisture-tolerant grasses, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

If this soil is properly drained, it is well suited to crops. If not drained, it is too wet for good crop production. Some areas do not have adequate drainage outlets; therefore, drainage may not be feasible. This soil is subject to soil blowing when drained. Frequent flooding or ponding is also a management concern.

This soil is generally unsuitable for buildings and septic tank absorption fields because flooding is a hazard. Structure damage may result because the soil strength is low. Soils that are better suited to these uses are usually nearby. Constructing roads on raised, well-compacted fill material and providing adequate side ditches and culverts help protect them from flood and frost damage.

This Palms soil is in capability subclass IIIw.

540—Seelyeville muck. This nearly level, very poorly drained soil is in broad areas along the Minnesota River flood plain and in upland depressions. It is subject to frequent flooding or ponding. Individual areas are irregular in shape and range from about 5 to 50 acres.

Typically, the surface layer is black muck about 6 inches thick. The middle layers are black and very dark grayish brown muck and mucky peat about 25 inches thick. The bottom layer to a depth of about 60 inches is black muck. In some places, the entire profile is mucky peat. Coprogenous earth or mineral material is within 51 inches of the surface in some areas.

Permeability of this Seelyeville soil is moderately rapid. The available water capacity is very high, and runoff is very slow to ponded. Reaction ranges from medium acid to mildly alkaline throughout the profile. Organic matter content is very high. Depth to seasonal high water table is less than 2 feet.

Most areas of this soil are left idle. This soil is well suited to wetland wildlife habitat, and suitable water habitat is easy to develop. Wetland food and cover crops grow well on this soil.

This soil is well suited to crops if artificially drained. The muck layer tends to subside after drainage and become thin after intensive cropping. This soil is subject to soil blowing if row crops are grown.

Undrained areas are fairly suited to pasture if well managed. This soil is well suited to reed canarygrass because it forms a tough, dense sod that can support grazing animals and haying equipment even though the soil is partially wet.

This soil is generally unsuitable for buildings and septic tank absorption fields because flooding is a hazard. Structure damage may result because the soil strength is low. Soils that are better suited to these uses are usually nearby. Constructing roads on raised, well-compacted fill material and providing adequate side ditches and culverts help protect them from flood and frost damage.

This Seelyeville soil is in capability subclass IVw.

545—Rondeau muck. This nearly level, very poorly drained soil is in broad areas along the Minnesota River flood plain and in upland depressions. It is subject to frequent flooding or ponding. Individual areas are irregular in shape and range from about 5 to 50 acres.

Typically, the surface layer is black muck about 10 inches thick. The middle layer is black muck about 35 inches thick. The bottom layer to a depth of about 60 inches is gray and light gray marl. In some places, a coprogenous earth layer and large stones are underlain by the marl. The depth to marl is more than 51 inches in some places.

Permeability of this Rondeau soil is moderately slow in the muck layers and slow in the marl layers. The available water capacity is very high, and runoff is very slow to ponded. Reaction in the lower layers is strongly acid through mildly alkaline. Organic matter content is very high. Depth to seasonal high water table is less than 1 foot.

Most areas of this soil are left idle. This soil is well suited to wetland wildlife habitat, and suitable water habitat is easy to develop. Wetland food and cover crops grow well on this soil.

This soil is well suited to crops if artificially drained. The muck layer tends to subside after drainage and become thin after intensive cropping. Because this soil is low lying, frost is a severe hazard early in the fall and late in the spring. This soil is subject to soil blowing if row crops are grown.

Undrained areas are fairly suited to pasture if well managed. This soil is well suited to reed canarygrass because it forms a tough, dense sod that can support grazing animals and haying equipment even though the soil is partially wet.

This soil is generally unsuitable for buildings and septic tank absorption fields because flooding is a hazard. Structure damage may result because the soil strength is low. Soils that are better suited to these uses are usually nearby. Constructing roads on raised, well-compacted fill material and providing adequate side ditches and culverts help protect them from flood and frost damage.

This Rondeau soil is in capability subclass IIIw.

611C—Hawick coarse sandy loam, 6 to 12 percent slopes. This sloping, excessively drained soil is on side slopes on outwash plains and stream terraces. Individual areas are irregular in shape and range from about 3 to 30 acres.

Typically, the surface layer is black and very dark grayish brown coarse sandy loam and gravelly loamy coarse sand about 11 inches thick. The subsoil is dark brown and dark yellowish brown gravelly loamy coarse sand and gravelly coarse sand about 10 inches thick. The underlying material to a depth of about 60 inches is yellowish brown very gravelly coarse sand. In some places, the surface texture is loam. Some areas do not have coarse fragments within 60 inches of the surface.

Included with this soil in mapping are small areas of the Salida soil, which averages more than 35 percent coarse fragments in the surface layer and subsoil. It is in convex positions within the delineation. This soil makes up 5 to 10 percent of the map unit.

Permeability of this Hawick soil is rapid in the upper part and very rapid in the lower part. The available water capacity is low, and runoff is medium. Reaction in the subsoil is slightly acid to mildly alkaline. Organic matter content is moderately low.

Most areas of this soil are cropland. This soil is poorly suited to crops commonly grown in the area because it has low available water capacity. Early maturing crops are best suited to this soil. Minimum tillage, no-till planting, cover crops, and field windbreaks reduce erosion and help to conserve moisture. This soil is well suited to irrigation; however, frequent applications are needed because the available water capacity is low.

This soil is fairly suited to pasture and hay. It provides fair pasture in spring, but during the summer supplemental pastures may be needed to insure

adequate production. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain a good cover of the more desirable grasses and reduce erosion. Where planting is necessary to improve stands, more drought-resistant plants are needed.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Hawick soil is in capability subclass IVs.

611D—Hawick coarse sandy loam, 12 to 18 percent slopes. This moderately steep, excessively drained soil is on side slopes on outwash plains and stream terraces. Individual areas are irregular in shape and range from about 3 to 25 acres.

Typically, the surface layer is black and very dark grayish brown coarse sandy loam and gravelly loamy coarse sand about 9 inches thick. The subsoil is dark brown and dark yellowish brown gravelly loamy coarse sand and gravelly coarse sand about 12 inches thick. The underlying material to a depth of about 60 inches is yellowish brown gravelly coarse sand. In some places, the surface texture is loam. Some areas do not have coarse fragments within 60 inches of the surface.

Included with this soil in mapping are small areas of the Salida soil, which averages more than 35 percent coarse fragments in the surface layer and subsoil. It is in convex positions within the delineation. This soil makes up 5 to 10 percent of the map unit.

Permeability of this Hawick soil is rapid in the upper part and very rapid in the lower part. The available water capacity is low, and runoff is rapid. Reaction in the subsoil is slightly acid to mildly alkaline. Organic matter content is moderately low.

Most areas of this soil are in pasture and hay. This soil is fairly suited to this use. It provides fair pasture in the spring and fall, but during the summer supplemental pastures may be needed to insure adequate production. Proper stocking, pasture rotation, and timely deferment of grazing help maintain a good cover of the more desirable grasses and reduce erosion. Where planting is necessary to improve plant stands, more drought-resistant plants are needed.

This soil is generally unsuitable for cultivated crops because it has low available water capacity and erosion is a hazard. Machinery operation may be difficult and unsafe on the moderately steep slopes. This soil is suited to irrigation. Frequent applications are needed, however, because the available water capacity is low, and intensive erosion control is needed to keep soil loss within allowable limits.

Slope is the main limitation to use of this soil for buildings. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope of the land. Large amounts of cut and fill materials are generally needed when constructing roads on this soil. Roads should be constructed on the contour and roadbanks planted to well-adapted grasses to minimize the erosion hazard. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Hawick soil is in capability subclass VIs.

611E—Hawick loamy sand, 18 to 25 percent slopes. This steep, excessively drained soil is on side slopes on outwash plains and in stream valleys. Individual areas are elongated and range from about 5 to 50 acres.

Typically, the surface layer is black and very dark grayish brown loamy sand about 9 inches thick. The subsoil is dark brown and dark yellowish brown gravelly loamy coarse sand and gravelly coarse sand about 12 inches thick. The underlying material to a depth of about 60 inches is yellowish brown gravelly coarse sand. In some areas the soil profile does not have free carbonates, has no coarse fragments, or has formed in uniform, fine sand. Also, some areas do not have a dark colored surface layer or have a redder subsoil.

Permeability of this Hawick soil is rapid in the upper part and very rapid in the lower part. The available water capacity is low, and runoff is very rapid. Reaction in the subsoil ranges from slightly acid to mildly alkaline. Organic matter content is moderately low. Depth to the seasonal high water table is more than 6 feet.

Most areas of this soil are unmanaged woodland. Seedling mortality is a problem because the available water capacity is very low. Planting in furrows helps to collect water needed by the planted stock. The hazard of erosion can be controlled by installing grass waterways or diversions to direct water across the slopes or by stabilizing existing gullies.

This soil is generally not suited to cultivated crops because of the steep slopes, the hazard of erosion, and the low available water capacity. Machinery operation may be difficult and unsafe because of the steep slopes.

This soil is poorly suited to pasture and hay because of the low available water capacity and erosion hazard. During the summer, supplemental pastures may be needed to insure adequate production. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain a good cover of the more desirable grasses

and reduce erosion. Where planting is necessary to improve stands, more drought-resistant plants are needed.

Slope is the main limitation to use of the soil for buildings. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope of the land. Large amounts of cut and fill materials are generally needed when constructing roads on this soil. Roads should be constructed on the contour and roadbanks planted to well-adapted grasses to minimize the erosion hazard. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Hawick soil is in capability subclass VIIs.

611F—Hawick loamy sand, 25 to 50 percent slopes. This very steep, excessively drained soil is on side slopes on outwash plains and in stream valleys. Individual areas are elongated and range from about 3 to 50 acres.

Typically, the surface layer is black and very dark grayish brown loamy sand about 7 inches thick. The subsoil is dark brown and dark yellowish brown gravelly loamy coarse sand and gravelly coarse sand about 14 inches thick. The underlying material to a depth of about 60 inches is yellowish brown gravelly coarse sand. In some areas the soil does not have free carbonates, has no coarse fragments, or has formed in uniform, fine sand. In other areas it does not have a dark colored surface layer or has a redder subsoil.

Permeability of this Hawick soil is rapid in the upper part and very rapid in the lower part. The available water capacity is low, and runoff is very rapid. Reaction in the subsoil ranges from slightly acid to mildly alkaline. Organic matter content is moderately low.

Most areas of this soil are unmanaged woodland. Seedling mortality is a problem because the available water capacity is low. Planting in furrows helps to collect water needed by planted stock. The hazard of erosion can be controlled by installing grass waterways or diversions to direct water across the slopes or by stabilizing existing gullies.

This soil is unsuited to crops because of the very steep slopes, the hazard of erosion, and the low available water capacity. Machinery operation may be difficult and unsafe.

This soil is poorly suited to pasture and hay because of the low available water capacity and the erosion hazard. During the summer supplemental pastures may be needed to insure adequate production. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain a good cover of the more desirable grasses and reduce erosion. Where planting is necessary to improve stands, more drought-resistant plants are needed.

This soil is generally unsuitable for buildings, roads, or septic tank absorption fields because it has very steep slopes.

This Hawick soil is in capability subclass VIIs.

857A—Urban land-Waukegan complex, 0 to 1 percent slopes. This level complex is on outwash plains. It consists mostly of Urban land and the well drained Waukegan soil. Individual areas are irregular in shape and range from about 10 to 150 acres. Up to 90 percent of this complex is Urban land. Areas of the Urban land and Waukegan soil are so small and form such an intricate pattern that it was not practical to map them separately.

The Urban land part of this complex is mainly in residential use. A few small shopping centers and their adjacent parking lots are included. In most areas covered by roads, buildings, or other structures, the characteristics of the original soil are so altered or obscured that identification is not feasible.

Typically, undisturbed areas of the Waukegan soil have surface and subsurface layers of silt loam which, combined, are about 13 inches thick. The surface layer is very dark brown, and the subsurface layer is very dark grayish brown. The subsoil is 29 inches thick. The upper part is dark brown and dark yellowish brown silt loam, and the lower part is dark yellowish brown sandy loam and gravelly coarse sand. The underlying material to a depth of about 60 inches is yellowish brown gravelly sand. In some places the upper sediments have a loam texture, and in some the surface layer is thinner and lighter colored. Other areas have been filled, leveled, or cut during construction.

Included with this unit in mapping are a few small areas of the Cylinder soil. It is somewhat poorly drained and is in slightly concave areas. This soil makes up about 5 percent of the map unit.

In Rosemount and Empire Townships, this map unit consists of cut and fill land in which the original soil material has been so altered that individual horizons are indistinguishable. Generally, the sandy underlying material has been mixed into the loamy surface layer and subsoil.

Undisturbed areas of the Waukegan soil have moderate permeability in the upper silty layers and rapid permeability in the underlying material. The available water capacity is moderate, and runoff is very slow. Reaction in the subsoil ranges from strongly acid to neutral. Organic matter content is high.

The soils in this map unit are suited to gardens and lawns. They are somewhat droughty, and frequent watering is necessary during the dry summer months. Trees and shrubs grow well in this map unit. This unit is well suited to buildings. Constructing roads on well-

compacted, coarse textured base material helps protect them from damage caused by low soil strength.

This Urban land-Waukegan complex has not been assigned a capability subclass.

857B—Urban Land-Waukegan complex, 1 to 8 percent slopes. This map unit is on gently sloping outwash plains. It consists mostly of Urban land and the well drained Waukegan soil. Individual areas are irregular in shape and range from about 10 to 150 acres. Up to 90 percent of this complex is Urban land. The areas of Urban land and Waukegan soil are so small and form such an intricate pattern that it was not practical to map them separately.

The Urban land part of this complex is mainly in residential use. A few small shopping centers and their adjacent parking lots are included. In most areas covered by roads, buildings, or other structures, the characteristics of the original soil are so altered or obscured that identification is not feasible.

Typically, undisturbed areas of Waukegan soil have silt loam surface and subsurface layers which, combined, are about 12 inches thick. The surface layer is very dark brown, and the subsurface layer is very dark grayish brown. The subsoil is about 27 inches thick. The upper part is dark brown and dark yellowish brown silt loam, and the lower part is dark yellowish brown sandy loam and gravelly coarse sand. The underlying material to a depth of about 60 inches is yellowish brown gravelly sand. In some places, the upper sediments have a loam texture, and in some the surface layer is thinner and lighter colored. Other areas have been filled, leveled, or cut during construction.

Included with this unit in mapping are a few small areas of the Cylinder soil. It is somewhat poorly drained and is in slightly concave areas. This soil makes up about 5 percent of the map unit.

Undisturbed areas of the Waukegan soil have moderate permeability in the upper silty layers and rapid permeability in the underlying material. The available water capacity is moderate, and runoff is medium. Reaction in the subsoil ranges from strongly acid to neutral. Organic matter content is high. The seasonal high water table is more than 6 feet deep.

The soils in this complex are suited to gardens and lawn. They tend to be somewhat droughty, and frequent watering may be necessary during the dry summer months. Trees and shrubs grow well in this map unit. Buildings constructed on this unit should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Constructing roads on well-compacted, coarse textured base material helps protect them from damage caused by low soil strength.

This Urban land-Waukegan complex has not been assigned a capability subclass.

858C—Urban land-Chetek complex, 1 to 15 percent slopes. This nearly level to moderately steep complex is on end moraines and pitted outwash plains. It consists of about 50 to 65 percent Urban land and 20 to 35 percent excessively drained Chetek soil. The areas of Urban land and Chetek soil are so small and form such an intricate pattern that it was not practical to map them separately. Individual areas are irregular in shape and range from about 10 to 500 acres.

The Urban land part of the map unit is covered by streets, parking lots, buildings, and other structures. These changes so obscure or alter the soils that soil identification is not feasible.

Typically, undisturbed areas of the Chetek soil have surface and subsurface layers of sandy loam which, combined, are about 7 inches thick. The surface layer is very dark brown, and the subsurface layer is very dark grayish brown. The subsoil is about 17 inches thick. The upper part is dark brown loam, and the lower part is strong brown gravelly loamy sand. The underlying material to a depth of about 60 inches is strong brown to yellowish brown gravelly sand. In some places the soil has been radically altered, and some areas have been filled, leveled, or cut during construction.

Included with this unit in mapping are a few small areas of the Kingsley and Mahtomedi soils. The well drained Kingsley soil formed in sandy glacial till. The excessively drained Mahtomedi soil has a sandy surface layer and subsoil. Each soil makes up about 5 percent of the map unit.

The permeability of the Chetek soil is moderately rapid in the loamy surface layer and subsoil and is rapid in the underlying sandy layers. The available water capacity is low, and runoff is slow to medium. The reaction of the subsoil ranges from slightly acid to strongly acid. The organic matter content is moderate.

Buildings constructed on this complex should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard.

The soils in this map unit have fair suitability for lawns, gardens, trees, and shrubs. The unit is droughty, and large quantities of water may be required for optimum plant growth. A covering loamy material is desirable before seeding or laying sod.

This Urban land-Chetek complex has not been assigned a capability subclass.

860C—Urban land-Lester complex, 3 to 15 percent slopes. This gently sloping to moderately steep complex is on hill crests and side slopes on end moraines. It consists of about 50 to 65 percent Urban land and 20 to 35 percent well drained Lester soil. The areas of Urban land and Lester soil are so small and form such an intricate pattern that it was not practical to map them

separately. Individual areas are irregular in shape and range from about 10 to 180 acres.

The Urban land part of the map unit is covered by streets, parking lots, buildings, and other structures. These changes so obscure or alter the soils that soil identification is not feasible.

Typically, in undisturbed areas the Lester soil has a surface layer of very dark brown loam about 6 inches thick. The subsoil is about 30 inches thick. It is dark brown loam and clay loam in the upper part and is brown loam in the lower part. The underlying material to a depth of about 60 inches is light yellowish brown and light olive brown loam. In some places the soil has been radically altered, and some areas have been filled, leveled, or cut during construction.

Included in this unit in mapping are a few small areas of the Le Sueur soil. It is moderately well drained to somewhat poorly drained and is in shallow depressions or is in adjacent drainageways. This soil makes up about 5 percent of the map unit.

The permeability of the Lester soil is moderate. The available water capacity is high, and runoff is medium to rapid. The reaction of the subsoil ranges from slightly acid to strongly acid. The organic matter content is moderate.

Buildings constructed on this complex should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. Lawns, gardens, trees, and shrubs all grow well on this map unit. A fertilization program is generally beneficial.

This Urban land-Lester complex has not been assigned a capability subclass.

861C—Urban land-Kingsley complex, 3 to 15 percent slopes. This undulating to rolling complex is on hill crests and side slopes on end moraines. It consists of about 50 to 65 percent Urban land and from 20 to 35 percent well drained Kingsley soil. The areas of Urban land and Kingsley soil are so small and form such an intricate pattern that it was not practical to map them separately. Individual areas are irregular in shape and range from about 10 to 400 acres.

The Urban land part of the map unit is covered by streets, parking lots, buildings, and other structures. These changes so obscure or alter the soils that soil identification is not feasible.

Typically, in undisturbed areas the Kingsley soil has a surface layer of black sandy loam about 8 inches thick. The subsurface layer is brown loamy sand about 4 inches thick. The subsoil is dark brown and reddish brown sandy loam about 26 inches thick. The underlying material to a depth of about 60 inches is dark brown sandy loam and loamy sand. In some places the underlying material has thin layers of silt loam, loam, or sand. Some areas have been filled, leveled, or cut during construction.

Included with this unit in mapping are a few small areas of the Auburndale, Chetek, and Kennebec soils. The poorly drained Auburndale soil is in shallow depressions. The somewhat excessively drained Chetek soil formed in loamy sediments and underlying sandy materials. The moderately well drained Kennebec soil formed in silty sediments in depressions. These soils make up about 15 percent of the map unit.

The permeability of the Kingsley soil is moderate in the surface layer and moderately slow in the subsoil and underlying material. The available water capacity is moderate, and runoff is rapid. The reaction of the subsoil ranges from slightly acid to strongly acid. The organic matter content is moderate.

Buildings constructed on this map unit should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. Trees and shrubs grow well on this map unit. Lawns and gardens grow better when topsoil is applied. A fertilization program is generally beneficial.

This Urban land-Kingsley complex has not been assigned a capability subclass.

861E—Urban land-Kingsley complex, 15 to 25 percent slopes. This hilly to steep complex is on side slopes and narrow ridge crests in end moraines. It consists of about 50 to 65 percent Urban land and 20 to 35 percent well drained Kingsley soil. The areas of Urban land and Kingsley soil are so small and form such an intricate pattern that it was not practical to map them separately. Individual areas are irregular in shape and range from about 10 to 200 acres.

The Urban land part of the map unit is covered by streets, parking lots, buildings, and other structures. These changes so obscure or alter the soils that soil identification is not feasible.

Typically, in undisturbed areas the Kingsley soil has a surface layer of black sandy loam about 6 inches thick. The subsurface layer is brown loamy sand about 4 inches thick. The subsoil is dark brown and reddish brown sandy loam about 20 inches thick. The underlying material to a depth of about 60 inches is dark brown sandy loam with thin layers of loamy sand. In some places the underlying material has thin layers of silt loam, loam, or sand. Some areas have been filled, leveled, or cut during construction.

Included with this unit in mapping are a few small areas of the Chetek and Kennebec soils. The somewhat excessively drained Chetek soil formed in a loamy surface mantle and underlying sandy materials. The moderately well drained Kennebec soils formed in silty

material in depressions. These soils make up about 15 percent of the map unit.

The permeability of the Kingsley soil is moderate in the surface layer and moderately slow in the subsoil and underlying material. The available water capacity is moderate, and runoff is very rapid. The reaction of the subsoil ranges from slightly acid to strongly acid. The organic matter content is moderate.

Slope is the main limitation for use of this complex for buildings. Extensive land shaping is generally needed. Buildings and lots should be designed to conform to the natural slope of the land. Large amounts of cut and fill materials are generally needed when constructing roads on this soil. Roads should be constructed on the contour, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard.

Trees and shrubs grow well on this map unit. Lawns and gardens grow better when topsoil is applied. Measures to control erosion are needed until the sod is established. A fertilization program is generally beneficial.

This Urban land-Kingsley complex has not been assigned a capability subclass.

865B—Urban land-Hubbard complex, 0 to 6 percent slopes. This nearly level to gently sloping complex is on outwash plains. It consists of about 50 to 65 percent Urban land and 20 to 35 percent excessively drained Hubbard soil. The areas of Urban land and Hubbard soil are so small and form such an intricate pattern that it was not practical to map them separately. Individual areas are irregular in shape and range from about 50 to 300 acres.

The Urban land part of the map unit is covered by streets, parking lots, buildings, and other structures. These changes so obscure or alter the soils that soil identification is not feasible.

Typically, in undisturbed areas the Hubbard soil has a surface layer of dark brown and very dark grayish brown loamy sand about 16 inches thick. The subsoil is dark brown loamy sand and sand about 22 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown sand. In some areas the surface layer is lighter colored. Also, in some areas this soil formed in fine sand.

In Rosemount and Empire townships, this map unit consists of broad areas of Waukegan and Wadena soils from which the upper loamy mantle has been removed. The underlying sand and gravel are exposed in these areas.

Included in this unit in mapping are a few small areas of the well drained to somewhat excessively drained Dickinson soil. It has a finer textured surface layer and subsoil. This soil makes up about 10 percent of the map unit.

The permeability of the Hubbard soil is rapid. The available water capacity is low, and runoff is slow. The reaction of the subsoil is strongly acid to neutral. The organic matter content is moderate.

This map unit is suitable for buildings and local roads.

This map unit is poorly suited to lawns, gardens, trees, and shrubs because it is droughty. A top dressing of loamy material should be applied to gardens and lawns, and they need to be frequently watered. A fertilization program is generally beneficial.

This Urban land-Hubbard complex has not been assigned a capability subclass.

880F—Brodale-Rock outcrop complex, 18 to 45 percent slopes. This complex consists of steep and very steep, excessively drained Brodale soil and Rock outcrop on stream valley side slopes. About 50 to 75 percent of this map unit is Brodale soil and 15 to 20 percent is Rock outcrop (fig. 13). The Brodale soil is on plane to slightly convex, mid and lower back slopes. The Rock outcrop is exposed near the shoulder slopes and on upper back slopes. Areas of the Brodale soil and Rock outcrop are so small and form such an intricate pattern that it was not practical to map them separately. Individual areas are elongated and range from about 10 to 80 acres.

Typically, the surface layer of the Brodale soil contains about 40 percent coarse fragments. It is very dark grayish brown flaggy loam about 6 inches thick. The subsoil is dark yellowish brown flaggy very fine sandy loam about 4 inches thick and is about 50 percent coarse fragments. The underlying material is yellowish brown flaggy very fine sandy loam and contains about 70 percent coarse fragments. Limestone bedrock is at a depth of about 47 inches. In some areas the reaction in the upper 20 inches of soil is neutral. Also, some areas have less than 15 percent coarse fragments in the surface layer and subsoil.

Typically, the Rock outcrop part of this map unit consists of limestone bedrock outcrops that are 2 to 4 feet high and 10 to 50 feet long. In some places sandstone bedrock is exposed on the lower foot slopes.

Permeability of the Brodale soil is moderate to moderately rapid. The available water capacity is low, and runoff is very rapid. Reaction is mildly alkaline or moderately alkaline in the subsoil layers. Organic matter content is moderate. Permeability is quite variable in the limestone bedrock outcrops.

Most areas of this map unit are in native hardwoods and are especially scenic. In some areas the lower part of the slopes is used for permanent pasture, but this soil is poorly suited to this use. This map unit is not suited to crops because the available water capacity is low and operating machinery is hazardous on the steep slopes. Droughtiness limits crop growth in most seasons. Maintaining a solid vegetative cover on the soil controls erosion.

Areas of this map unit used for woodland wildlife should be managed to protect existing habitat and to

Figure 13.—This typical landscape of the Brodale-Rock outcrop complex, 18 to 45 percent slopes, shows warm-season vegetation.

maintain or improve its quality. Management for wildlife habitat also enhances these areas for scenic purposes.

This map unit is generally unsuitable for buildings, roads, or septic tank absorption fields because slopes are steep and very steep.

This Brodale-Rock outcrop complex is in capability subclass VIIs.

888B—Kingsley-Lester complex, 2 to 6 percent slopes. This gently sloping, well drained complex is on side slopes and ridge crests of end moraines. Individual areas of this unit are irregular in shape and range from about 5 to 80 acres. About 40 to 60 percent of this unit is Kingsley soil and 20 to 40 percent Lester soil. Areas of these soils are so small and form such an intricate pattern that it was not practical to map them separately.

Typically, the surface layer of the Kingsley soil is black sandy loam about 8 inches thick. The subsurface layer is brown loamy sand about 5 inches thick. The subsoil is dark brown and reddish brown sandy loam about 26 inches thick. The underlying material to a depth of about 60 inches is dark brown loamy sand and sandy loam. In some areas the underlying material contains layers of loam, silt loam, or sand.

Typically the surface layer of the Lester soil is very dark brown loam about 6 inches thick. The subsoil is about 32 inches thick. It is dark brown loam and clay loam in the upper part and brown loam in the lower part. The underlying material to a depth of about 60 inches is light yellowish brown and light olive brown loam. In some areas the subsoil and underlying material have firm consistence.

Included with this unit in mapping are a few small areas of the Estherville and Le Sueur soils. The somewhat excessively drained Estherville soil formed in a loamy layer and in the underlying sandy materials. It is on convex knobs. The moderately well drained to somewhat poorly drained Le Sueur soils are on nearly

level spots or in shallow depressions. Each soil makes up about 5 percent of the map unit.

The permeability is moderate in the upper part and moderately slow in the lower part of the Kingsley soil and moderate in the Lester soil. The available water capacity is moderate in the Kingsley soil and high in the Lester soil. Runoff is medium. The reaction of the subsoil ranges from slightly acid to strongly acid. Organic matter content is moderate.

This map unit is fairly suited to cultivated crops. Erosion is the main management concern. It can be controlled by using minimum tillage, returning crop residues to the soil, or including hay crops in the rotation. Contour farming also reduces erosion but is difficult because the slopes are short and irregular. Stoniness limits the use of some farm equipment.

This map unit is well suited to pasture and hay. Including legume and grass forage in the cropping system reduces erosion, builds up nitrogen in the soil, and improves tilth for future crops. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain the most productive plants. Droughtiness limits forage growth during dry seasons.

This complex is well suited to woodland. Most trees grow well if competing vegetation is controlled.

Buildings constructed on this map unit should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Foundations and footings should be designed to prevent structure damage caused by shrinking and swelling of the Lester soil. Backfilling around foundations with suitable coarse material will provide added protection against structure damage. Constructing roads on well-compacted, coarse textured base material helps protect them from damage caused by low soil strength. The moderately slow permeability of the Kingsley soil restricts its use for septic tank absorption fields, but installing a larger-than-average drainage field will help to overcome this limitation.

This Kingsley-Lester complex is in capability subclass IIIe.

888C—Kingsley-Lester complex, 6 to 12 percent slopes. This sloping, well drained complex is on side slopes and narrow ridge crests on end moraines. Individual areas are irregular in shape and range from about 5 to 80 acres. About 40 to 60 percent of this unit is Kingsley soil and about 20 to 40 percent Lester soil. Areas of these soils are so small and form such an intricate pattern that it was not practical to map them separately.

Typically, the surface layer of the Kingsley soil is black sandy loam about 8 inches thick. The subsurface layer is brown loamy sand about 4 inches thick. The subsoil is dark brown and reddish brown sandy loam about 26 inches thick. The underlying material to a depth of about 60 inches is dark brown loamy sand and sandy loam. In some places the underlying material contains layers of silt loam, loam, or sand.

Typically the surface layer of the Lester soil is very dark brown loam about 6 inches thick. The subsoil is about 30 inches thick. It is dark brown loam and clay loam in the upper part and brown loam in the lower part. The underlying material to a depth of about 60 inches is light yellowish brown and light olive brown loam. In some areas the dark colored surface layer is eroded. Also, in some areas, the subsoil and underlying material have firm consistence.

Included with this unit in mapping are a few small areas of the Estherville and Le Sueur soils. The somewhat excessively drained Estherville soil formed in a loamy layer and underlying sandy materials. It is on convex knobs. The moderately well drained to somewhat poorly drained Le Sueur soil is on nearly level spots or in shallow depressions. Each soil makes up about 5 percent of the map unit.

The permeability is moderate in the upper part and moderately slow in the lower part of the Kingsley soil and moderate in the Lester soil. The available water capacity is moderate in the Kingsley soil and high in the Lester soil. Runoff is rapid. The reaction of the subsoil ranges from slightly acid to strongly acid. Organic matter content is moderate.

This map unit has fair suitability for cultivated crops. Erosion is the main management concern. It can be reduced by using minimum tillage, returning crop residues to the soil, and including hay in the crop rotation. Contour farming also reduces erosion but may be difficult because slopes are short and irregular. Stoniness limits the use of some farm equipment.

This complex is well suited to pasture. Overgrazing causes erosion, and droughtiness limits forage growth during dry seasons. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain the most productive plants.

This map unit is well suited to woodland. Most trees grow well if competing vegetation is controlled.

Slope is the main limitation for buildings. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope of the land. Slope and low soil strength in the Lester soil are the main limitations for road construction. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. Constructing roads on well-compacted, coarse textured base material will help protect them from damage caused by low soil strength. The slope and moderate to moderately slow permeability of this unit restrict its use for septic tank absorption fields, but installing a larger-than-average drainage field and placing distribution lines across the slope will help to overcome these limitations.

This Kingsley-Lester complex is in capability subclass IIIe.

888D—Kingsley-Lester complex, 12 to 18 percent slopes. This moderately steep, well drained complex is on side slopes on end moraines. Individual areas are irregular in shape and range from about 3 to 50 acres. About 40 to 60 percent of this unit is Kingsley soil and about 20 to 40 percent Lester soil. Areas of these soils are so small and form such an intricate pattern that it was not practical to map them separately.

Typically, the surface layer of the Kingsley soil is black sandy loam about 7 inches thick. The subsurface layer is brown loamy sand about 4 inches thick. The subsoil is dark brown and reddish brown sandy loam about 22 inches thick. The underlying material to a depth of about 60 inches is dark brown loamy sand and sandy loam. In some places the underlying material contains layers of silt loam, loam, or sand.

Typically, the surface layer of the Lester soil is dark brown loam about 5 inches thick. The subsoil is about 29 inches thick. It is dark brown loam and clay loam in the upper part and brown loam in the lower part. The underlying material to a depth of about 60 inches is light yellowish brown and light olive brown loam. In some areas, the dark colored surface layer is eroded. Also, in some areas the subsoil and underlying material have firm consistence.

Included with this unit in mapping are a few small areas of the Estherville soil The somewhat excessively drained Estherville soil has a sandy subsoil and underlying material. It is on convex knobs. This soil makes up about 10 percent of the map unit.

The permeability is moderate in the upper part and moderately slow in the lower part of the Kingsley soil and moderate in the Lester soil. The available water capacity is moderate in the Kingsley soil and high in the Lester soil. Runoff is very rapid. The reaction of the subsoil ranges from slightly acid to strongly acid. Organic matter content is moderate.

This map unit is poorly suited to cultivated crops. Because slopes are moderately steep, erosion can be severe. It can be minimized by maintaining a solid vegetative cover. Stoniness limits the use of some farm equipment.

This complex is fairly suited to pasture. Overgrazing causes erosion, and droughtiness limits forage growth during dry seasons. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain the most productive plants.

This map unit has fair suitability for woodland. Many areas are wooded and are especially scenic. Most trees grow well if competing vegetation is controlled. Destruction of the ground cover causes erosion. The steep slopes limit the use of some equipment on these soils.

Slope is the main limitation for buildings. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope of the land. Slope and low soil strength in the Lester soil are the main limitations for road construction. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. Constructing roads on well-compacted, coarse textured base material will help protect them from damage caused by low soil strength. The slope and moderate to moderately slow permeability of this map unit restrict its use for septic tank absorption fields, but installing a larger than average drainage field and placing distribution lines across the slope will help to overcome these limitations.

This Kingsley-Lester complex is in capability subclass IVe.

889B—Wadena-Hawick complex, 2 to 6 percent slopes. This gently sloping, well drained to excessively drained complex is on outwash plains and in valley trains. Individual areas are irregular in shape and range from about 10 to 40 acres. About 60 percent of the map unit is Wadena soil and about 30 percent is Hawick soil. Areas of these soils are so small and form such an intricate pattern that it was not practical to map them separately.

Typically, the surface layer of the Wadena soil is black loam about 9 inches thick. The subsurface layer is very dark brown and dark grayish brown loam about 7 inches thick. The subsoil is about 22 inches thick. The upper part is dark brown loam, and the lower part is dark yellowish brown sandy loam and loamy sand. The underlying material to a depth of about 60 inches is dark yellowish brown and brown gravelly loamy sand and sand. In some places the surface layer is up to 12 inches thick.

Typically, the surface and subsurface layers of the Hawick soil are black and very dark grayish brown coarse sandy loam and gravelly loamy coarse sand about 11 inches thick. The subsoil is dark brown and dark yellowish brown gravelly loamy coarse sand and gravelly coarse sand about 10 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 loamy.

Included with this unit in mapping are a few small areas of the Jewett and Kennebec soils. The moderately well drained Kennebec soil formed in deep silt in depressions. The Jewett soil formed in silt underlain by sandy loam glacial till. These soils make up 5 to 10 percent of this map unit.

Permeability is moderate in the loamy mantle and rapid in the sandy underlying material of the Wadena soil and rapid in the upper part and very rapid in the lower part of the Hawick soil. The available water capacity is moderate in the Wadena soil and low in the Hawick soil. The surface runoff is medium. Reaction in the subsoil is medium acid to mildly alkaline. Organic matter content is moderate in the Wadena soil and moderately low in the Hawick soil.

Most areas of this map unit are cropland. These soils are fairly suited to crops commonly grown in the area. Corn, soybeans, and small grains are the main crops. Droughtiness during years of low rainfall can reduce crop yields. There is a slight hazard of erosion on the steeper slopes. Using minimum tillage, returning crop residue to the soil, and including forage in the rotation reduce erosion. This map unit is suited to irrigation; however, frequent applications are needed because the Hawick soil has low available water capacity and rapid permeability. Also, timing of irrigation is difficult because the properties of this map unit are extremely variable.

This map unit is well suited to pasture and hay. It provides good pasture in the spring and fall, but during the summer supplemental pastures may be needed to insure adequate production. Proper stocking, rotation grazing, fertilizing, and controlling weeds help to maintain a good cover of the more desirable grasses and reduce erosion. Where planting is necessary to improve stands, more drought-resistant plants are needed.

Buildings constructed on this map unit should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. This map unit is suitable for road construction and is a good source of sand and gravel. This unit readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Wadena-Hawick complex is in capability subclass IIIs.

889C—Wadena-Hawick complex, 6 to 12 percent slopes. This sloping, well drained to excessively drained complex is on outwash plains and in valley trains. Individual areas are irregular in shape and range from about 10 to 40 acres. About 50 percent of the map unit is Wadena soil and about 40 percent is Hawick soil. Areas of these soils are so small and form such an intricate pattern that it was not practical to map them separately.

Typically, the surface layer of the Wadena soil is black loam about 7 inches thick. The subsurface layer is very dark brown and dark grayish brown loam about 5 inches thick. The subsoil is about 15 inches thick. The upper part is dark brown loam, and the lower part is dark yellowish brown loam. The underlying material to a depth of about 60 inches is dark yellowish brown and brown gravelly loamy sand and sand.

Typically, the surface layer of the Hawick soil is black and coarse sandy loam, and the subsurface layer is gravelly coarse sand. Combined, they are about 11 inches thick. The subsoil is dark brown and dark yellowish brown gravelly loamy coarse sand and gravelly coarse sand about 10 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 loamy.

Included with this unit in mapping are a few small areas of the Jewett and Kennebec soils. The moderately well drained Kennebec soil formed in deep silt loam in depressions. The Jewett soil formed in silt loam underlain by sandy loam till. These soils make up 5 to 10 percent of this map unit.

Permeability is moderate in the loamy mantle and rapid in the sandy underlying material of the Wadena soil and is rapid in the upper part and very rapid in the lower part of the Hawick soil. The available water capacity is moderate in the Wadena soil and low in the Hawick soil. The surface runoff is medium. Reaction in the subsoil is medium acid to mildly alkaline. Organic matter content is moderate in the Wadena soil and moderately low in the Hawick soil.

Most areas of this map unit are cropland. These soils are fairly suited to crops commonly grown in the area. Corn, soybeans, and small grains are the main crops. Droughtiness during years of low rainfall can reduce crop yields. Early maturing crops are best suited to these soils. There is a hazard of erosion. Using minimum tillage, returning crop residue to the soil, and including forage in the rotation reduce erosion.

This map unit is suited to irrigation; however, frequent applications are needed because the Hawick soil has rapid permeability and low available water capacity. Also, timing of irrigation is difficult because the properties of this map unit are extremely variable.

This map unit is fairly suited to pasture and hay. It provides fair pasture in the spring and fall, but during the summer supplemental pastures may be needed to insure adequate production. Proper stocking, rotation grazing, fertilizing, and controlling weeds help to maintain a good cover of the more desirable grasses and reduce erosion. Where planting is necessary to improve stands, more drought-resistant plants are needed. Keeping these areas covered with vegetation reduces erosion.

Buildings constructed on this map unit should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. This map unit readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Wadena-Hawick complex is in capability subclass IVe.

889D—Wadena-Hawick complex, 12 to 18 percent slopes. This moderately steep to steep well drained to

excessively drained complex is on outwash plains and in valley trains. Individual areas are irregular in shape and range from about 5 to 30 acres. Generally, the Wadena soil makes up about 50 percent of the map unit and the Hawick soils make up about 40 percent. Areas of these soils are so small and form such an intricate pattern that it was not practical to map them separately.

Typically, the surface layer of the Wadena soil is black loam about 7 inches thick. The subsurface layer is very dark brown and dark grayish brown loam about 5 inches thick. The subsoil is about 18 inches thick. The upper part is dark brown loam, and the lower part is dark yellowish brown loam. The underlying material to a depth of about 60 inches is dark yellowish brown and brown gravelly loamy sand and sand.

Typically, the surface layer of the Hawick soil is black coarse sandy loam, and the subsurface layer is very dark grayish brown gravelly loamy coarse sand. Combined, they are about 9 inches thick. The subsoil is dark brown and dark yellowish brown gravelly loamy coarse sand and gravelly coarse sand about 12 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 loamy.

Permeability is moderate in the loamy mantle and rapid in the sandy underlying material of the Wadena soil and is rapid in the upper part and very rapid in the lower part of the Hawick soil. The available water capacity is moderate in the Wadena soil and low in the Hawick soil. The surface runoff is rapid. Reaction in the subsoil is medium acid to mildly alkaline. Organic matter content is moderate in the Wadena soil and moderately low in the Hawick soil.

Most areas of this map unit are in pasture and hay. These soils are fairly suited to this use. They provide fair pasture in the spring and fall, but during the summer supplemental pastures may be needed to insure adequate production. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain a good cover of the more desirable grasses and reduce erosion. Where planting is necessary to improve plant stands, more drought-resistant plants are needed. Keeping these areas covered with vegetation reduces erosion.

This map unit is poorly suited to cultivated crops because of the low to moderate available water capacity and the severe hazard of erosion. Early maturing crops, such as small grains, are best suited to these soils. Using minimum tillage and no-till planting and including cover crops in the cropping system reduce erosion.

This map unit is suited to irrigation; however, frequent applications are needed because the Hawick soils have very low available water capacity and rapid permeability.

Slope is the main limitation for buildings. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope of the land. Large amounts of cut and fill materials are generally needed when constructing roads on this map unit. Roads should be constructed on the contour, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. This map unit is poorly suited to septic tank absorption fields because slopes are steep and the soil does not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface and placing them across the slope. In some areas additional precautionary measures may be needed.

This Wadena-Hawick complex is in capability subclass IVs.

895B—Kingsley-Mahtomedi-Spencer complex, 3 to 8 percent slopes. These undulating to rolling, well drained, excessively drained, and moderately well drained soils are on end moraines. Individual areas are irregular in shape and range from about 5 to 200 acres. This complex is 30 to 60 percent Kingsley soils, 20 to 40 percent Mahtomedi soils, and 10 to 30 percent Spencer soils. Individual areas of these soils are so small and form such an intricate pattern that it was not practical to map them separately.

Typically, the surface layer of the Kingsley soil is black sandy loam about 8 inches thick. The subsurface layer is brown loamy sand about 5 inches thick. The subsoil is dark brown and reddish brown sandy loam about 26 inches thick. The underlying material to a depth of about 60 inches is dark brown loamy sand and sandy loam. In some areas the underlying material contains layers of silt loam, loam, or sand.

Typically, the surface layer of the Mahtomedi soil is very dark grayish brown loamy sand about 7 inches thick. The subsoil is dark brown and dark yellowish brown gravelly coarse sand and coarse sand about 35 inches thick. The underlying material to a depth of about 60 inches is yellowish brown sand and gravelly coarse sand.

Typically, the surface layer of the Spencer soil is dark grayish brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown silt loam about 6 inches thick. The subsoil is about 32 inches thick. The upper part is yellowish brown and dark yellowish brown silt loam and silty clay loam. The lower part is yellowish brown mottled silt loam. The underlying material is dark brown mottled sandy loam. In some areas the silty materials are more than 5 feet thick.

Included with this complex in mapping are a few small areas of the moderately well drained Kennebec Variant soil in closed depressions. This soil makes up about 10 percent of the map unit.

Permeability is moderate in the upper part and moderately slow in the lower part of the Kingsley soil, rapid in the Mahtomedi soil, and moderate in the Spencer soil. The available water capacity is moderate in the Kingsley soil, low in the Mahtomedi soil, and high in the Spencer soil. Runoff is medium. The reaction of the

subsoil ranges from slightly acid to strongly acid. The organic matter content ranges from low to moderate. The seasonal high water table is below 6 feet in the Kingsley and Mahtomedi soils and is at a depth of 2.5 to 6 feet in the Spencer soil.

This complex has fair suitability for cultivated crops, but erosion is a management concern. Erosion can be reduced by using minimum tillage, returning crop residues to the soils, and including hay crops in the rotation. Contour farming also reduces erosion but is difficult on the short, irregular slopes. Droughtiness limits crop growth, particularly on the Kingsley and Mahtomedi soils. Early maturing crops are best suited to these soils. Stoniness hinders the use of some farm equipment.

This complex is well suited to pasture and hay. Including legume and grass forage in the cropping system reduces erosion, builds up nitrogen in the soil, and improves tilth for future crops. Droughtiness limits forage growth during dry periods on the Kingsley and Mahtomedi soils. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain the most productive plants.

This map unit has fair suitability for woodlands. Seedling mortality is severe on the Mahtomedi soil, and drought-tolerant trees, such as pines, should be selected. Most trees grow well on the Kingsley and Spencer soils if competing vegetation is controlled.

Buildings constructed on these soils should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. The soils are suitable for road construction. This map unit is poorly suited to septic tank absorption fields because the Mahtomedi soil has poor filtering ability, the Kingsley soil does not readily absorb effluent, and the Spencer soil has a high water table. The poor filtering capacity of the Mahtomedi soils may result in the pollution of ground-water supplies. These limitations can be reduced by installing a larger-than-average drainage field close to the surface. In some areas a mound-type absorption field may be suitable.

This Kingsley-Mahtomedi-Spencer complex is in capability subclass IIIe.

895C—Kingsley-Mahtomedi-Spencer complex, 8 to 15 percent slopes. This rolling to hilly, well drained, excessively drained, and moderately well drained map unit is on side slopes and ridge crests of end moraines. Individual areas are irregular in shape and range from about 5 to 200 acres. This complex is 30 to 60 percent Kingsley soils, 20 to 30 percent Mahtomedi soils, and 10 to 20 percent Spencer soils. Individual areas of these soils are so small and form such an intricate pattern that it was not practical to map them separately.

Typically, the surface layer of the Kingsley soil is black sandy loam about 8 inches thick. The subsurface layer is brown loamy sand about 4 inches thick. The subsoil is dark brown and reddish brown sandy loam about 26 inches thick. The underlying material to a depth of about 60 inches is dark brown loamy sand and sandy loam. In some places the underlying material contains layers of silt loam, loam, or sand.

Typically, the surface layer of the Mahtomedi soil is very dark grayish brown loamy sand about 5 inches thick. The subsoil is dark brown and dark yellowish brown gravelly coarse sand and coarse sand about 30 inches thick. The underlying material to a depth of about 60 inches is yellowish brown sand and gravelly coarse sand.

Typically, the surface layer of the Spencer soil is dark grayish brown silt loam about 6 inches thick. The subsurface layer is dark grayish brown silt loam about 5 inches thick. The subsoil is yellowish brown to dark yellowish brown silt loam and silty clay loam about 30 inches thick, and it is mottled in the lower part. The underlying material is dark brown mottled sandy loam. In some places the silty materials are more than 5 feet thick.

Included with this complex in mapping are a few small areas of the moderately well drained Kennebec Variant soil in closed depressions. This soil makes up about 10 percent of the map unit.

Permeability is moderate in the upper part and moderately slow in the lower part of the Kingsley soil, rapid in the Mahtomedi soil, and moderate in the Spencer soil. The available water capacity is moderate in the Kingsley soil, low in the Mahtomedi soil, and high in the Spencer soil. Runoff is rapid. The reaction of the subsoil ranges from slightly acid to strongly acid. The organic matter content ranges from low to moderate. The seasonal water table is at a depth of 2.5 to 6 feet in the Spencer soil and more than 6 feet in the Kingsley and Mahtomedi soils.

The soils of this complex are poorly suited to cultivated crops. Erosion is the main management concern. It can be reduced by using minimum tillage, returning crop residues to the soil, or including hay crops in the rotation. Contour farming is difficult on the short, irregular slopes. Because droughtiness limits crop growth during dry seasons, early maturing crops are best suited to these soils. Stoniness hinders the use of some farm equipment.

This complex is well suited to pasture and hay. Including legume and grass forage in the cropping system reduces erosion, builds up nitrogen in the soil, and improves tilth for future crops. Droughtiness limits forage growth during dry seasons, and overgrazing causes erosion. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain the most productive plants.

This map unit is fairly suited to woodland. Most trees grow well if competing vegetation is controlled, although seedling mortality is severe on the Mahtomedi soils. Drought-resistant trees, such as pines, should be selected.

Buildings constructed on these soils should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads should be constructed on the contour, when possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. These soils are poorly suited to septic tank absorption fields. The Mahtomedi soil has poor filtering ability, the Kingsley soil does not readily absorb effluent, and the Spencer soil has a high water table. The poor filtering capacity of the Mahtomedi soils may result in the pollution of ground-water supplies. These limitations can be reduced by installing larger than average drainage fields close to the surface. In some areas a mound-type absorption field may be suitable.

This Kingsley-Mahtomedi-Spencer complex is in capability subclass IVe.

896E—Kingsley-Mahtomedi complex, 15 to 25 percent slopes. This hilly to steep, well drained and excessively drained complex formed on side slopes and narrow crests of ridges and hills on end moraines. Individual areas are irregular in shape and range from about 5 to 200 acres. About 30 to 70 percent of this map unit is Kingsley soil and 20 to 50 percent Mahtomedi soil. Areas of these soils are so small and form such an intricate pattern that it was not practical to map them separately.

Typically, the surface layer of the Kingsley soil is black sandy loam about 6 inches thick. The subsurface layer is brown loamy sand about 4 inches thick. The subsoil is dark brown and reddish brown sandy loam about 20 inches thick. The underlying material to a depth of about 60 inches is dark brown loamy sand and sandy loam. In some areas the underlying material contains layers of loam, silt loam, or sand.

Typically, the surface layer of the Mahtomedi soil is very dark grayish brown loamy sand about 4 inches thick. The subsoil is dark brown and dark yellowish brown gravelly coarse sand and coarse sand about 28 inches thick. The underlying material to a depth of about 60 inches is yellowish brown sand and gravelly coarse sand.

Included with this unit in mapping are a few small areas of the Kennebec Variant soil. The moderately well drained Kennebec Variant soil is in depressions. This soil makes up 10 percent of the map unit.

The permeability of the Kingsley soil is moderate in the upper part and moderately slow in the lower part. It is rapid in the Mahtomedi soil. The available water capacity is moderate in the Kingsley soil and low in the Mahtomedi soil. Runoff is very rapid. The reaction of the subsoil ranges from slightly acid to strongly acid. The organic matter content is moderate in the Kingsley soil and low in the Mahtomedi soil.

This map unit is generally not suitable for cultivated crops because slopes are steep and erosion is a severe hazard. Erosion and runoff can be minimized by maintaining a vegetative cover. Steep, irregular slopes and stoniness limit the use of farm equipment on this soil.

These soils are fairly suited to pasture. Overgrazing causes severe erosion, and droughtiness limits forage growth during dry seasons. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain an adequate vegetative cover and reduce erosion.

These soils are also fairly suited to woodland. Areas of this map unit that are in woodlands are especially scenic. Most trees grow well if competing vegetation is controlled. Seedling mortality is severe on the Mahtomedi soils. Drought-tolerant trees, such as pines, should be selected. If the ground cover is disturbed, erosion may be severe.

Slope is the main limitation for buildings. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope of the land. Large amounts of cut and fill materials are generally needed when constructing roads on this map unit. Roads should be constructed on the contour, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. This map unit is poorly suited to septic tank absorption fields because the Mahtomedi soil has poor filtering ability and the Kingsley soil does not readily absorb effluent. The poor filtering capacity of the Mahtomedi soil may result in the pollution of ground-water supplies. These limitations can be reduced by installing a larger-than-average drainage field close to the surface. In some areas additional precautionary measures may be needed.

This Kingsley-Mahtomedi complex is in capability subclass VIe.

896F—Kingsley-Mahtomedi complex, 25 to 40 percent slopes. This very steep, well drained and excessively drained complex is on side slopes on end moraines. Individual areas are irregular in shape and range from about 5 to 30 acres. This map unit is 40 to 60 percent Kingsley soil and 20 to 50 percent Mahtomedi soil. Areas of these soils are so small and form such an intricate pattern that it was not practical to map them separately.

Typically, the surface layer of the Kingsley soil is black sandy loam about 3 inches thick. The subsurface layer is brown loamy sand about 4 inches thick. The subsoil is dark brown and reddish brown sandy loam about 18 inches thick. The underlying material to a depth of about 60 inches is dark brown loamy sand and sandy loam. In some places, the underlying material has layers of silt loam, loam, or sand.

Typically, the surface layer of the Mahtomedi soil is very dark grayish brown loamy sand about 3 inches thick. The subsoil is dark brown gravelly coarse sand and coarse sand about 20 inches thick. The underlying

material to a depth of about 60 inches is yellowish brown sand and gravelly coarse sand.

The permeability is moderate in the upper part and moderately slow in the lower part of the Kingsley soil and rapid in the Mahtomedi soil. The available water capacity is moderate in the Kingsley soil and low in the Mahtomedi soil. Runoff is very rapid. The reaction of the subsoil ranges from slightly acid to strongly acid. The organic matter content is moderate in the Kingsley soil and is low in the Mahtomedi soil.

Most areas of this map unit are woodland. These soils have fair suitability for this use. Many of the wooded tracts are especially scenic. If the ground cover is damaged, erosion may be severe. Steep slopes limit the use of equipment. Seedling mortality may be severe, and drought-tolerant trees, such as pines, should be selected.

This complex is not suited to cultivated crops. It is hazardous to use most farm equipment on these very steep slopes.

These soils are poorly suited to pasture because the slopes are very steep. Overgrazing causes severe runoff and erosion, and droughtiness limits forage growth during dry seasons.

Slope is the main limitation for buildings. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope of the land. Large amounts of cut and fill materials are generally needed when constructing roads on this map unit. Roads should be constructed on the contour, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. These soils are generally not suitable for septic tank absorption fields because they have steep slopes, the Mahtomedi soil has poor filtering ability, and the Kingsley soil does not readily absorb effluent. The poor filtering capacity of the Mahtomedi soil may result in the pollution of ground-water supplies.

This Kingsley-Mahtomedi complex is in capability subclass VIs.

963C2—Timula-Bold silt loams, 6 to 12 percent slopes, eroded. This sloping, well drained complex is on side slopes and narrow ridge crests of loess-mantled uplands. Individual areas are irregular in shape and range from about 3 to 100 acres. About 40 to 70 percent of this map unit is Timula soil and 20 to 40 percent Bold soil. Areas of these soils are so small and form such an intricate pattern that it was not practical to map them separately (fig. 14).

Figure 14.—The light-colored Timula and Bold soils are on the knolls and side slopes. The dark-colored Lindstrom soils are on the foot slopes adjacent to grassed waterways.

Typically, the surface layer of the Timula soil is dark brown silt loam about 8 inches thick. The subsoil is yellowish brown silt loam about 12 inches thick. The underlying material to a depth of about 60 inches is calcareous yellowish brown silt loam. Some areas have a thicker and darker surface layer.

Typically, the surface layer of the Bold soil is yellowish brown silt loam about 8 inches thick. The underlying material to a depth of about 60 inches is yellowish brown silt loam. This soil is calcareous throughout.

Included with this unit in mapping are a few areas of the Lindstrom and Waukegan, bedrock substratum, soils. The Lindstrom soil has a thicker, darker colored surface layer and is on foot slopes and in the upper parts of drainageways. This soil makes up about 10 percent of the map unit. The Waukegan, bedrock substratum, soil has limestone as shallow as 36 inches from the surface and is along slope breaks. This soil makes up about 5 percent of the map unit.

The permeability of the Timula and Bold soils is moderate. The available water capacity is very high, and runoff is rapid. The reaction of the subsoil ranges from slightly acid to moderately alkaline. The organic matter content ranges from very low to moderate.

Most areas of this map unit are used for cultivated crops. These soils have fair suitability for that use. Corn, soybeans, and small grains are the main crops. This map unit consists of highly erodible soils. Farming on the contour, using minimum tillage, terracing, and including hay in the crop rotations reduce erosion.

These soils are well suited to pasture and hay. Including legume and grass forage in the cropping system reduces erosion, builds up nitrogen in the soil, and improves tilth for future crops. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain a good cover of the more desirable grasses and reduce erosion.

These soils are fairly suited to woodland. Most trees grow well if competing vegetation is controlled.

Buildings constructed on this map unit should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Constructing roads on well-compacted, coarse textured base material helps protect them from frost damage. Land shaping and installing the distribution lines across the slope is generally necessary for septic tank absorption fields to function properly.

These Timula-Bold soils are in capability subclass IIIe.

963D2—Timula-Bold silt loams, 12 to 18 percent slopes, eroded. This moderately steep, well drained complex is on side slopes of loess-mantled uplands. Individual areas are irregular in shape and range from about 3 to 40 acres. About 30 to 60 percent of this map unit is Timula soil and 30 to 50 percent Bold soil. Areas of these soils are so small and form such an intricate pattern that it was not practical to map them separately.

Typically, the surface layer of this Timula soil is dark brown silt loam about 8 inches thick. The subsoil is yellowish brown silt loam about 12 inches thick. The underlying material to a depth of about 60 inches is calcareous, yellowish brown silt loam. Some areas have a thicker, darker surface layer.

Typically, the surface layer of this Bold soil is yellowish brown silt loam about 8 inches thick. The underlying material to a depth of about 60 inches is yellowish brown silt loam. This soil is calcareous throughout.

Included in mapping are a few small areas of the Marlean soil. It has highly fractured limestone in the subsoil and substratum and is along slope breaks. This soil makes up about 5 percent of the map unit.

The permeability of the Timula-Bold soils is moderate. The available water capacity is very high, and runoff is very rapid. The reaction of the subsoil ranges from slightly acid to moderately alkaline. The organic matter content ranges from very low to moderate.

Most areas of these soils are idle or are used for pasture. These soils are fairly suited to pasture. The hazard of erosion is the main management concern. Proper stocking, pasture rotation, and timely deferment of grazing reduce the erosion hazard and help to maintain the pasture in good condition.

These soils are poorly suited to cultivated crops because of steep slopes and a severe hazard of erosion. Using minimum tillage and incorporating plant residues or forages in the cropping rotation reduce runoff and erosion.

This map unit is fairly suited to woodland. The erosion hazard and the difficulty in operating equipment on these steep slopes are limiting factors. Erosion can be reduced by maintaining a good understory ground cover and limiting the excessive equipment, which destroys this ground cover. Black walnut, red oak, and silver maple are some of the more desirable trees to plant.

Slope is the main limitation for buildings. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope of the land. Roads should be constructed on the contour, when possible, and roadbanks planted to well-adapted grasses to minimize the erosion hazard. Constructing roads on well-compacted, coarse textured base material helps protect them from frost damage. Land shaping and installing the distribution lines across the slope is generally necessary for septic tank absorption fields to function properly.

These Timula-Bold soils are in capability subclass IVe.

963E2—Timula-Bold silt loams, 18 to 25 percent slopes, eroded. This steep, well drained complex is on side slopes on loess-mantled uplands. Individual areas are irregular in shape and range from about 3 to 20 acres. About 20 to 50 percent of this map unit is Timula

soil and 40 to 70 percent Bold soil. Areas of these soils are so small and form such an intricate pattern that it was not practical to map them separately.

Typically, the surface layer of the Timula soil is dark brown silt loam about 8 inches thick. The subsoil is yellowish brown silt loam about 10 inches thick. The underlying material to a depth of about 60 inches is calcareous, yellowish brown silt loam.

Typically, the surface layer of the Bold soil is yellowish brown silt loam about 8 inches thick. The underlying material to a depth of about 60 inches is yellowish brown silt loam. This soil is calcareous throughout.

Included in mapping are a few small areas of the Marlean soil. It contains highly fractured limestone in the subsoil and substratum and is along slope breaks. This soil makes up about 5 percent of the map unit.

The permeability of these Timula and Bold soils is moderate. The available water capacity is very high, and runoff is very rapid. The reaction of the subsoil ranges from slightly acid to moderately alkaline. The organic matter content ranges from moderate to very low.

Most areas of this map unit are idle or are used for pasture. These soils are fairly suited to pasture. The hazard of erosion is the main management concern. Proper stocking, pasture rotation, and timely deferment of grazing reduce the erosion hazard and help to maintain the pasture in good condition.

This map unit is generally not suitable for cultivated crops because of the steep slopes and the severe hazard of erosion. The use of farm machinery on these slopes is difficult and often hazardous.

This map unit is fairly suited to woodland. The erosion hazard and the difficulty in operating equipment on these steep slopes are the main concerns. Erosion can be reduced by maintaining a good understory ground cover and avoiding excessive equipment operation, which destroys this ground cover. Black walnut, red oak, and silver maple are some of the desirable trees to plant.

Slope is the main limitation for buildings. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope of the land. Roads should be constructed on the contour, when possible, and roadbanks planted to well-adapted grasses to minimize the erosion hazard. Constructing roads on well-compacted, coarse textured base material helps protect them from frost damage. Land shaping and installing the distribution lines across the slope is generally necessary for septic tank absorption fields to function properly.

These Timula-Bold soils are in capability subclass VIe.

1013—Pits, quarry. These are miscellaneous areas that have been mined for limestone or sandstone. The areas include excavations and piles of unconsolidated materials such as bedrock fragments. Water is in the deeper parts of some quarries. Soil features such as relief, slope, and drainage vary greatly.

If the topsoil is carefully stockpiled before quarrying, some parts of the quarries can be reclaimed. The use that can be made of such reclaimed land depends on the nature of the original soil—its drainage, slope, and depth. Onsite investigations are needed to best determine the potentials and limitations of this unit for any proposed use.

Pits, quarry, have not been assigned a capability subclass.

1027—Udorthents, wet. This map unit consists of heterogeneous, earthy fill material and industrial waste that has been placed on poorly drained and very poorly drained mineral or organic soils. It provides sites for buildings, roads, recreation areas, and other uses. Areas are irregular in shape and range from about 2 to 80 acres.

The fill material is 2 feet or more thick. It is a mixture of organic and inorganic waste and sandy, gravelly, loamy, and silty soil material. Earthy soil material makes up about 80 percent of the unit. The other 20 percent is nonsoil material, such as bricks, trash, wire, metal, boards, and pieces of concrete and stones. Small areas of soils that have not been significantly altered by filling or covering make up a small percentage of this map unit.

In Rosemount and Empire Townships, this map unit consists of the Waukegan and Wadena soils that have up to 18 inches of fill material over the original soil surface. The fill is made up of crushed rock, ground-up concrete, or sand and gravel.

Permeability and available water capacity of this unit are variable. In some highly compacted areas, water ponds on the surface after heavy rainfall. Runoff and internal drainage are also variable. Depth to the seasonal high water table varies from 1 to more than 6 feet.

Many areas of this unit are nearly level, contain only small amounts of coarse fragments, and are used for lawns, trees, vegetable gardens, and recreational uses. Areas which contain large amounts of coarse fragments or are composed of sandy soil materials are poorly suited to these uses. Many areas of this map unit are almost totally covered with buildings, asphalt, concrete, or other impervious surfaces. Settling may be a problem in areas that are underlain with organic soil material. Preferably, the organic material should be completely removed before the depression is filled. Settling may cause maintenance problems if the soil is used for streets, sidewalks, and pipelines. The ease of establishing and maintaining vegetation varies, depending on the properties of the fill. A detailed onsite investigation is needed to determine potentials and limitations of these areas for any proposed use.

These Udorthents have not been assigned a capability subclass.

1029—Pits, gravel. These areas are, or were, used for mining sand or gravel. They consist of excavations,

stockpiles of sand and gravel, areas filled with waste, and water. Individual areas are irregular in shape and range from about 3 to 500 acres.

Included with this area in mapping are borrow pits that are formed by the removal of loamy earthy material.

These areas are being reclaimed and used for several purposes. Reclamation generally includes extensive filling amd grading. Some areas where the topsoil was stockpiled are being reclaimed for agricultural use. Pits are suitable for the disposal of refuse that will not cause ground-water pollution. Some areas are suitable for and are used for commercial, industrial, or residential development. Wildlife or recreational areas can be developed by revegetating and utilizing the ponds that often form in pits. An onsite investigation is needed to determine potentials and limitations of these areas for any proposed use.

The Pits, gravel, have not been assigned to a capability subclass.

1039—Urban land. This level to gently sloping map unit is mostly in the northern part of Dakota County, but also is in areas along the Mississippi and Minnesota Rivers. These areas generally are irregular in shape and range from about 5 to more than 160 acres. More than 90 percent of the surface of this map unit is covered with buildings, asphalt, concrete, or other impervious surfaces. Identification of the soils in these areas is not feasible because they have been greatly altered in various ways by construction. Developments on these areas include factories, shopping centers, warehouses, railroad yards, and parking lots.

Included with this unit in mapping are areas of idle land that have been cut or filled.

Runoff following rains is high and often flows into storm drainage systems. If improperly channeled, runoff from nearby areas causes severe erosion. Vegetation is generally in narrow strips along sidewalks, between roadways, and in isolated islands. Such vegetated areas total less than 5 percent of the map unit. Onsite investigation is essential to properly evaluate and plan development for specific purposes.

This Urban land has not been assigned a capability subclass.

1055—Aquolls and Histosols, ponded. This map unit consists of level, very poorly drained mineral and organic soils around lakes or rivers and in depressions on till plains and outwash plains. Some areas are dry late in summer or during periods of drought, but most areas are continuously ponded. An individual area may consist of only one of the soils, or it may have both.

Most mapped areas are covered with a dense growth of water-tolerant vegetation and include small areas of open water.

This map unit provides excellent habitat for wetland wildlife. It provides feeding, nesting, and escape areas for waterfowl, furbearers, and upland game. Many of these areas can be improved for wildlife production by controlling the water level, by increasing nesting and courting areas for waterfowl, and by fencing out livestock.

Because of the high water table and the lack of suitable drainage outlets, these soils are generally unsuitable for crops, pasture, woodland, urban development, and sanitary facilities. Where drainage is feasible, preliminary investigations are needed to determine the nature and thickness of the soil material and the feasibility of the proposed use.

These Aquolls and Histosols, ponded, are in capability subclass VIIIw.

1072—Udorthents, moderately shallow. This map unit consists of areas of an active sanitary landfill where solid waste is covered daily. Some of these areas filled with soil and waste material are higher in elevation than the adjacent soils.

The surface varies from nearly level in some of the filled areas to moderately steep in areas being filled. The site to be filled changes enough each day that the entire area gradually becomes higher in elevation.

The final soil cover is thick enough to support plants. It is dark or moderately dark, alkaline or calcareous material. The active part of the area consists of refuse of variable texture, concrete fragments, construction materials, and other waste that is dumped and smoothed out.

This map unit needs onsite investigation to determine use, suitability, and management requirements.

These Udorthents, moderately shallow, have not been assigned a capability subclass.

1815—Zumbro loamy fine sand. This nearly level, well drained and moderately well drained soil is in broad swales on outwash plains. Individual areas are irregular in shape and range from about 5 to 30 acres.

Typically, the surface layer is black fine sandy loam about 18 inches thick. The subsurface layer is very dark gray loamy fine sand about 38 inches thick. The subsoil to a depth of about 60 inches is dark brown fine sand. In some pedons the dark surface layer is less than 24 inches thick.

Permeability of this Zumbro soil is rapid. The available water capacity is low, and runoff is slow. The reaction of the subsoil is slightly acid to moderately alkaline. Organic matter content is moderately slow.

Most areas of this soil are cropland. This soil is fairly suited to crops commonly grown in the area. Corn, soybeans, and small grains are the main crops. The low available water capacity is the main management concern. Early maturing crops are best suited to this soil. Soil blowing is a problem, and young plants are easily damaged by blowing sand. Minimum tillage, no-till planting, cover crops, and field windbreaks reduce soil

blowing and help to conserve moisture. This soil is well suited to irrigation; however, frequent applications are needed because the available water capacity is low.

This soil is fairly suited to pasture and hay. It provides fair pasture in the spring and fall, but during the summer supplemental pastures may be needed to insure adequate production. Proper stocking, rotation grazing, fertilizing, and controlling weeds help maintain a good cover of the more desirable grasses and reduce erosion.

This soil is suitable for buildings and roads. It readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Zumbro soil is in capability subclass IIIs.

1816—Kennebec Variant silt loam. This nearly level, moderately well drained soil is in closed depressions on end moraines. Individual areas are generally circular or oval and range from about 3 to 25 acres. This soil is subject to ponding.

Typically, the surface layer is very dark gray silt loam about 10 inches thick. The next layer is very dark gray silt loam and loam about 27 inches thick. Below this is a buried soil that is black silty clay loam about 15 inches thick. The subsoil to a depth of about 60 inches is very dark gray silt loam.

Included with this soil in mapping are a few areas of the very poorly drained Quam soil. This soil is in the deepest parts of some depressions. It makes up about 5 to 10 percent of the map unit.

The permeability of this Kennebec Variant soil is moderate. The available water capacity is very high, and runoff is slow to ponded. The reaction in the subsoil ranges from slightly acid to neutral. Organic matter content is high. The seasonal high water table is above a depth of 2 feet.

Most areas of this soil are idle. Some areas are used for crops, and this soil is well suited to this use. Occasional ponding is a management concern. Wetness delays fieldwork in the spring. Using minimum tillage, including forages in the cropping rotation, and returning crop residue to the soil help to maintain tilth.

This soil is well suited to pasture and hay. Productivity is good for all recommended forage crops. Grazing early in the spring and after heavy rains should be delayed to prevent pasture damage and soil compaction. Proper stocking, rotation grazing, controlling weeds, and fertilizing are good management practices.

This soil is well suited to trees. Plant competition is the main management concern. Existing woodland can be improved by thinning out the mature and undesirable trees.

This soil is generally unsuitable for buildings or septic tank absorption fields because of the ponding hazard. Soils that are better suited to these uses are generally nearby. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts protect them from damage caused by ponding, frost action, and low soil strength.

This Kennebec Variant is in capability subclass IIw.

1821—Algansee sandy loam, occasionally flooded. This nearly level, somewhat poorly drained soil is on flood plains of major rivers. Individual areas are commonly elongated and range from about 40 to 200 acres.

Typically, the surface layer is very dark grayish brown sandy loam about 12 inches thick. The underlying material to a depth of about 60 inches is dark brown and dark yellowish brown sand with a few mottles. In some areas this soil has thin layers of loamy sand, sandy loam, or loam. Also, in some areas the underlying material does not have mottles. In some areas along the Mississippi River this soil will not flood as frequently because there are flood control structures upstream.

Permeability of this Algansee soil is very rapid. The available water capacity is low, and runoff is slow. Reaction in the underlying material ranges from medium acid to moderately alkaline. Organic matter content is moderate to moderately low. The seasonal high water table is at a depth of 1 to 2 feet.

Most areas of this soil are used for pasture or are idle forest land. This soil has fair suitability for pasture and is limited by low production during dry summer months. It is difficult to keep a good vegetative cover on this soil, and overgrazing causes it to blow easily.

This soil has fair suitability for trees. Growth is limited by the low available water capacity. Seedling mortality is moderate, and survival of seedlings is dependent on timely rainfall. Seedlings are subject to damage from flooding and soil blowing. Planting trees in furrows reduces soil blowing and conserves moisture. Site preparation is necessary to control competing vegetation.

This soil is well suited to most crops commonly grown in the area. Corn and soybeans are the main crops. When this soil is cropped, low available water capacity, soil blowing, and flooding are the main concerns of management. Early maturing crops, such as small grains, are best suited to this soil. Using minimum tillage or maintaining a cover of crop residues reduces soil blowing.

This soil can be used for parks, recreation areas, and wildlife sanctuaries. Areas that are less seldom flooded are suitable for picnic areas. Flooding is not so severe a limitation because peak use generally occurs after floodwaters have receded.

This soil is generally unsuitable for buildings or septic tank absorption fields because flooding is a hazard. Soils that are better suited to these uses are usually nearby. Constructing roads on raised, coarse textured fill material

and providing adequate side ditches and culverts protect them from damage caused by flooding.

This Algansee soil is in capability subclass IIIw.

1824—Quam silt loam, ponded. This level, very poorly drained soil is in closed depressions and around lake borders on end moraines. Individual areas are oval and range from 3 to about 20 acres. This soil is commonly ponded in all seasons. The central part of the delineation is commonly open water, but vegetation is in the shallower areas in the center and around the edges.

Typically, the surface layer is very dark grayish brown silt loam about 19 inches thick. The subsurface is black silt loam about 26 inches thick. The underlying material to a depth of about 60 inches is grayish brown silt loam.

Included with this soil in mapping are small areas of the Palms soil. It formed in organic material and is in the center of some deep depressions. This soil makes up 5 to 10 percent of the map unit.

Permeability of the Quam soil is moderately slow in the upper part and moderate in the lower part. The available water capacity is high, and runoff is ponded. The reaction of the solum ranges from strongly acid to slightly acid. Organic matter content is high. The seasonal high water table is more than 1 foot above the soil surface in all seasons.

Most areas of this soil are idle. This soil is well suited to wetland wildlife habitat. It provides feeding, nesting, and escape areas and can be improved for wildlife production by controlling the water level, by increasing nesting and courting areas for waterfowl, and by fencing these areas and keeping out livestock.

This soil is generally not suited to crops and pasture because flooding is a continuous hazard. Drainage is often difficult or not feasible because there is no suitable outlet.

This soil is generally unsuitable for buildings or septic tank absorption fields because ponding is a hazard. Soils that are better suited to these uses are usually nearby. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts protect them from damage caused by ponding, frost action, and low soil strength.

This Quam soil is in capability subclass VIIw.

1825C—Seelyeville muck, sloping. This gently sloping to steep, very poorly drained soil is at the base of escarpments along the Minnesota River Valley. Individual areas are elongated and range from about 10 to 60 acres.

Typically, the surface layer is black muck about 6 inches thick. The middle layers are black and very dark grayish brown muck and mucky peat about 25 inches thick. The bottom layer to a depth of about 60 inches is black muck. In some pedons the entire profile is mucky peat. Also some pedons have mineral material within 51 inches of the surface.

Included with this soil in mapping are areas of very seepy mineral soils. They occur at the contact of this map unit and the very steep escarpment. These soils make up 5 to 10 percent of the map unit.

Permeability of this Seelyeville soil is moderately rapid. The available water capacity is very high, and runoff is slow to moderate. Reaction ranges from strongly acid to mildly alkaline throughout the profile. Organic matter content is very high. The depth to the water table is 0 to 2 feet.

Most areas of this soil are idle and should be preserved because they are unique and especially scenic. This soil provides suitable habitat for wetland wildlife; however, the steep slopes make it difficult to construct and maintain open water areas.

This soil is generally not suitable for cultivated crops. Soil wetness, severe erosion hazard, and soil blowing are management concerns. Farming equipment is difficult to maneuver on the steep slopes because this soil has low strength.

This soil is poorly suited to pasture and hay. Soil compaction and the erosion hazard are limitations that are difficult to overcome.

This soil is generally unsuitable for buildings, roads, and sanitary facilities. The high water table and low soil strength are limitations that are difficult to overcome. Soils that are better suited are usually nearby.

This Seelyeville soil is in capability subclass VIw.

1827A—Waukegan silt loam, bedrock substratum, 0 to 2 percent slopes. This nearly level, well drained soil is on hilltops on loess-mantled, bedrock-cored uplands and on outwash plains. Individual areas are irregular in shape and range from about 5 to 30 acres.

Typically, the surface layer is black silt loam about 14 inches thick. The subsurface layer is very dark grayish brown silt loam about 3 inches thick. The subsoil is dark yellowish brown silt loam about 19 inches thick. The underlying material is dark brown sand about 4 inches thick. Limestone bedrock is at a depth of about 40 inches. In some pedons the bedrock is at a depth of more than 48 inches. Also, some pedons do not have sand layers above bedrock.

Included with this soil in mapping are a few small areas of the Rockton soil. This soil has bedrock at a depth of 20 to 40 inches, has more sand in the surface and subsurface layers than does the Waukegan soil, and is similar in position to the Waukegan soil. This soil makes up 5 to 10 percent of the map unit.

Permeability of this Waukegan soil is moderate in the upper silty mantle and rapid in the underlying soil and bedrock. The available water capacity is moderate, and runoff is slow. The reaction of the subsoil is medium acid to neutral. The organic matter content is high. The root zone ranges from 30 to 45 inches deep.

Most areas of this soil are used for cultivated crops, and it is well suited to that use. Because it has moderate

available water capacity, droughtiness may occur during dry periods. Using minimum tillage and returning crop residues to the soil improve tilth, conserve moisture, and increase infiltration. This soil is well suited to irrigation.

This soil is also well suited to pasture and hay. Including legume and grass forage in the cropping system reduces erosion, builds up nitrogen in the soil, and improves tilth for future crops. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain the most productive plants.

Excavation for buildings and roads may be difficult because of the underlying bedrock, and large machinery may be required. This soil is poorly suited to septic tank absorption fields because of its depth to bedrock and poor filtering ability. The poor filtering capacity may result in the pollution of ground-water supplies, and the bedrock may hinder the installing of distribution lines in some areas. These limitations can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be needed.

This Waukegan soil is in capability subclass IIs.

1827B—Waukegan silt loam, bedrock substratum, 2 to 6 percent slopes. This gently sloping, well drained soil is on broad ridges and hilltops on loess-mantled, bedrock-cored uplands. Individual areas are irregular in shape and range from about 5 to 50 acres.

Typically, the surface layer is black silt loam about 14 inches thick. The subsurface layer is very dark grayish brown silt loam about 3 inches thick. The subsoil is dark yellowish brown silt loam about 19 inches thick. The underlying material is dark brown sand about 4 inches thick. Limestone bedrock is at a depth of about 40 inches. In some pedons the bedrock is at a depth of more than 60 inches. Also, some pedons do not have sand layers above the bedrock.

Included with this soil in mapping are a few small areas of the Rockton soil. This soil has bedrock at a depth of 20 to 40 inches and has more sand in the surface and subsurface layers than does the Waukegan soil. It is similar in position to the Waukegan soil. This soil makes up 5 to 10 percent of the map unit.

Permeability of this Waukegan soil is moderate in the upper mantle and rapid in the underlying soil and bedrock. The available water capacity is moderate, and runoff is medium. The reaction of the subsoil is strongly acid to neutral. The organic matter content is high. The root zone ranges from 30 to 45 inches deep.

Most areas of this soil are cropland. This soil is well suited to all crops commonly grown in the area. Corn, soybeans, and small grains are the main crops. This soil is easily eroded by water. Leaving crop residue on the surface, either by minimum tillage or by stubble mulching, increases infiltration and reduces runoff and erosion. Extra cover during seeding and early crop growth helps to prevent erosion. Farming on the contour also reduces erosion.

This soil is well suited to pasture and hay. Including legume and grass forage in the cropping system reduces erosion, builds up nitrogen in the soil, and improves tilth for future crops. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain the most productive plants.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Excavation for buildings and roads may be difficult in some areas because of the underlying bedrock, and large machinery may be required. This soil is poorly suited to septic tank absorption fields because of its depth to bedrock and poor filtering ability. The poor filtering capacity may result in the pollution of ground-water supplies, and the bedrock may hinder the installing of distribution lines in some areas. These limitations can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be needed.

This Waukegan soil is in capability subclass IIe.

1827C—Waukegan silt loam, bedrock substratum, 6 to 12 percent slopes. This sloping, well drained soil is on broad ridges and hilltops on loess-mantled, bedrock-cored uplands. Individual areas are irregular in shape and range from about 5 to 30 acres.

Typically, the surface layer is black silt loam about 12 inches thick. The subsurface layer is very dark grayish brown silt loam about 3 inches thick. The subsoil is dark yellowish brown silt loam about 12 inches thick. The underlying material is dark brown sand about 4 inches thick. Limestone bedrock is at a depth of about 40 inches. Some pedons do not have sand layers above the bedrock.

Included with this soil in mapping are a few small areas of the Rockton soil. This soil has bedrock at a depth of 25 to 40 inches and has more sand in the surface and subsurface layers than the Waukegan soil. It is similar in position to the Waukegan soil. This soil makes up 5 to 10 percent of the map unit.

Permeability of the Waukegan soil is moderate in the upper silty mantle and rapid in the underlying soil and bedrock. The available water capacity is moderate, and runoff is rapid. The reaction of the subsoil is strongly acid to neutral. The organic matter content is high.

Most areas of this soil are used for cultivated crops, and it is well suited to this use. Corn, soybeans, and small grains are the main crops. The soil erodes easily, but using minimum tillage, farming on the contour, and including cover crops in the cropping system reduce erosion and runoff.

This soil is well suited to pasture and hay. Including legume and grass forage in the cropping system reduces erosion, builds up nitrogen in the soil, and improves tilth for future crops. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain the most

productive plants, reduce erosion, and keep the soil in good condition.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Excavation for buildings and roads may be difficult in some areas because of the underlying bedrock, and large machinery may be required. Roads should be constructed on the contour, when possible, and roadbanks planted to well-adapted grasses to minimize the erosion hazard. This soil is poorly suited to septic tank absorption fields because of its depth to bedrock and poor filtering ability. The poor filtering capacity may result in the pollution of ground-water supplies. The bedrock may hinder the installing of distribution lines in some areas. These limitations can be reduced by installing distribution lines close to the surface. In some areas precautionary measures may be needed.

This Waukegan soil is in capability subclass IIIe.

1848B—Sparta loamy sand, bedrock substratum, 2 to 8 percent slopes. This gently sloping to sloping, excessively drained soil is on bedrock-cored uplands. Individual areas are irregular in shape and range from about 5 to 40 acres.

Typically, the surface layer is very dark grayish brown and dark brown loamy fine sand about 10 inches thick. The subsoil is dark yellowish brown loamy fine sand or fine sand about 15 inches thick. The underlying material is yellowish brown fine sand to a depth of about 38 inches, and limestone bedrock is at a depth of about 42 inches. The bedrock is generally separated from the sand by a layer of brown clay loam about 4 inches thick. In some pedons the sand is less than 24 inches or more than 60 inches deep.

Included with this soil in mapping are a few small areas of Rockton soil. This soil has silty and loamy layers over bedrock and is slightly higher than the Sparta soil. This soil makes up 5 to 10 percent of the map unit.

Permeability of the Sparta soil is rapid in the upper part and moderately slow in the material underlain by the bedrock. The available water capacity is low, and runoff is slow. Reaction of the subsoil is medium acid or strongly acid. The organic matter content is moderately low.

Most areas of this soil are cropland. This soil is poorly suited to crops commonly grown in the area because it has low available water capacity. Early maturing crops are best suited to this soil. Soil blowing is a problem, and young plants are easily damaged by blowing sand. Minimum tillage, no-till planting, cover crops, and field windbreaks reduce soil blowing and conserve moisture. This soil is well suited to irrigation; however, the rapid permeability and very low available water capacity are disadvantages.

This soil is fairly suited to pasture and hay. Droughtiness is a problem. This soil provides fair pasture in the spring and fall, but during the summer supplemental pastures may be needed to insure adequate production. Proper stocking, pasture rotation, and timely deferment of grazing help to keep the soil and pasture in good condition. Where planting is necessary to improve stands, more drought-resistant plants are needed. Keeping these areas covered with vegetation reduces erosion.

This soil is fairly suited to woodland. Seedling mortality is a management problem because the available water capacity is low. Plant competition is also a management concern.

Excavation for buildings may be difficult because of the underlying bedrock and may require the use of large machinery. This soil is suitable for road construction. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface. In some areas additional precautionary measures may be necessary.

This Sparta soil is in capability subclass IVs.

1894B—Winnebago loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on plane or convex side slopes of upland till plains. Individual areas are irregular in shape and range from about 10 to 80 acres.

Typically, the surface layer is black and very dark brown loam about 15 inches thick. The subsoil is dark reddish brown, yellowish red, and reddish brown sandy clay loam about 29 inches thick. The underlying material to a depth of about 60 inches is reddish brown sandy loam. In some areas depth to limestone or sandstone bedrock is as little as 40 inches.

Included with this soil in mapping are small areas of the Burkhardt and Carmi soils. The Burkhardt soil is somewhat excessively drained and is on knolls or crests. The Carmi soil has more sand and gravel in the solum than the Winnebago soil. Also it is similar in position to the Winnebago soil. These soils make up 10 to 15 percent of the map unit.

Permeability of the Winnebago soil is moderate. The available water capacity is high, and runoff is medium. Reaction in the subsoil ranges from strongly acid to slightly acid. Organic matter content is moderate.

Most areas of this soil are cropland. This soil is well suited to crops. Corn, soybeans, and small grains are the main crops. Controlling erosion on the steeper, longer slopes is the main concern of management. Using minimum tillage, stubble mulching, and returning crop residues to the soil increase the organic matter content and water infiltration and reduce runoff and erosion.

This soil is well suited to pasture and hay. Proper stocking, rotation grazing, fertilizing, and controlling weeds help keep the pasture and soil in good condition.

Also, including legume and grass forage in the cropping system reduces erosion.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Foundations and footings should be designed to prevent structure damage caused by shrinking and swelling of the soil. Backfilling around foundations with suitable coarse materials provides added protection against structure damage. Constructing roads on well-compacted, coarse textured base material helps protect them from damage caused by frost action and shrinking and swelling. This soil is suitable for use as septic tank absorption fields.

This Winnebago soil is in capability subclass IIe.

1895B—Carmi loam, 2 to 8 percent slopes. This gently sloping to sloping, well drained soil is on plane or convex side slopes of uplands. Individual areas are irregular in shape and range from about 10 to 150 acres.

Typically, the surface layer is black and very dark grayish brown loam about 13 inches thick. The subsoil is about 35 inches thick. The upper part is dark yellowish brown and dark brown loam and sandy loam. The lower part is strong brown and dark brown loamy sand and gravelly sandy loam. The underlying material to a depth of about 60 inches is yellowish red gravelly loamy sand. In some areas limestone or sandstone bedrock is as shallow as 40 inches. Also, in some areas the underlying material contains less than 15 percent coarse fragments.

Included with this soil in mapping are small areas of the Burkhardt and Winnebago soils. The Burkhardt soil is somewhat excessively drained and is on knolls or crests. The Winnebago soil has more clay in the subsoil than the Carmi soil and is similar in position. These soils make up 5 to 10 percent of the map unit.

Permeability of the Carmi soil is moderately rapid in the upper part and rapid in the underlying material. The available water capacity is moderate, and runoff is medium. Reaction in the subsoil is strongly acid to neutral. Organic matter content is moderate.

Most areas of this soil are cropland. This soil is well suited to crops. Corn, soybeans, and small grains are the main crops. Controlling erosion on the steeper, longer slopes is the main concern of management. Using minimum tillage, stubble mulching, farming on the contour, and returning crop residues to the soil increase organic matter content and the available water capacity of the soil and also reduce runoff and erosion.

This soil is well suited to pasture and hay. Proper stocking, rotation grazing, fertilizing, and controlling weeds help keep the pasture and soil in good condition. Also, including legume and grass forage in the cropping system reduces erosion.

Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Constructing roads on well-compacted, coarse textured base material helps protect them from frost damage. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface.

This Carmi soil is in capability subclass IIe.

1896B—Ostrander-Carmi loams, 2 to 6 percent slopes. This gently sloping, well drained map unit is on plane or convex side slopes of upland till plains. The soils formed in loamy glacial till and loamy sediments underlain by stratified glacial drift. Individual areas are irregular in shape and range from about 5 to 90 acres. This unit is 40 to 60 percent Ostrander soil and 30 to 40 percent Carmi soil. Individual areas are so small or form such an intricate pattern that it was not practical to map them separately.

Typically, the Ostrander soil has surface and subsurface layers of loam which, combined, are about 17 inches thick. The surface layer is black, and the subsurface layer is very dark grayish brown. The subsoil is yellowish brown loam about 36 inches thick. The underlying material to a depth of about 60 inches is yellowish brown loam.

Typically, the Carmi soil has a surface layer of black and very dark grayish brown loam about 13 inches thick. The subsoil is about 35 inches thick. The upper part is dark yellowish brown and dark brown loam and sandy loam, and the lower part is strong brown and dark brown loamy sand and gravelly sandy loam. The underlying material to a depth of about 60 inches is yellowish red gravelly loamy sand. In some areas limestone or sandstone bedrock is as shallow as 40 inches. In some areas the underlying material has less than 15 percent coarse fragments.

Included in mapping are small areas of the Dickinson and Klinger soils. The Dickinson soil is well drained or somewhat excessively drained and is similar in position to the Ostrander-Carmi soils. The Klinger soil is somewhat poorly drained and is in slightly concave position. These soils make up 5 to 15 percent of the map unit.

Permeability is moderate in the Ostrander soil. It is moderately rapid in the upper part of the Carmi soil and rapid in the lower part. The available water capacity is high in the Ostrander soil and moderate in the Carmi soil. Runoff is medium. Reaction in the subsoil is neutral to strongly acid. Organic matter content is moderate.

Most areas of this map unit are cropland. These soils are well suited to crops. Corn, soybeans, and small grains are the main crops. Controlling erosion on the steeper, longer slopes is the main concern of management. Using minimum tillage, stubble mulching, farming on the contour, and returning crop residues to the soil increase the organic matter content and water infiltration of the soil and reduce runoff and erosion.

This map unit is well suited to pasture and hay. Proper stocking, rotation grazing, fertilizing, and controlling weeds help keep the pasture and soil in good condition. Including legume and grass forage in the cropping system reduces erosion.

Buildings constructed on this map unit should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Constructing roads on well-compacted, coarse textured base material helps protect them from frost damage. The Carmi soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity may result in the pollution of ground-water supplies, but this limitation can be reduced by installing distribution lines close to the surface.

These Ostrander-Carmi soils are in capability subclass IIe.

1898F—Etter-Brodale complex, 25 to 60 percent slopes. This deep, very steep, excessively drained and well drained map unit is on bedrock-controlled slopes of valley walls. Individual areas are commonly elongated and range from about 5 to 60 acres. About 40 to 50 percent of this unit is Etter soil and 25 to 40 percent is Brodale soil. The Etter soil is on plane to slightly convex, mid and lower back slopes. The Brodale soil is on convex shoulders and upper parts of back slopes. Areas of these soils are so small and form such an intricate pattern that it was not practical to map them separately.

Typically, the Etter soil has a surface layer of very dark grayish brown fine sandy loam about 12 inches thick. The subsoil is dark brown fine sandy loam about 8 inches thick. The underlying material to a depth of about 60 inches is brownish yellow and brown fine sand. In some places thin layers of shale are in the lower part of the subsoil. In some places, the surface layer and subsoil contain 3 to 5 percent limestone fragments. In some areas on nose slopes, texture in the surface layer and subsoil is loamy sand or sand.

Typically, the Brodale soil has a surface layer of very dark grayish brown flaggy loam about 6 inches thick. It is about 40 percent, by volume, coarse limestone fragments. The subsoil is dark yellowish brown, flaggy very fine sandy loam about 4 inches thick. It is about 50 percent coarse fragments of limestone. The underlying material is yellowish brown flaggy very fine sandy loam that is about 70 percent limestone fragments. Limestone bedrock is at a depth of about 47 inches. In some areas, the reaction in the upper 20 inches of soil is neutral. Also, some areas have less than 15 percent coarse fragments in the surface layer and subsoil.

Permeability is moderate in the upper part and rapid in the lower part of the Etter soil and moderate to moderately rapid in the Brodale soil. The available water capacity is moderate in the Etter soil and low in the Brodale soil. Runoff is very rapid. Reaction in the subsoil is moderately alkaline to strongly acid. Organic matter content is moderate. The root zone is shallow to bedrock.

Most areas of this map unit remain in native hardwoods and are especially scenic. In some areas the lower parts of slopes are used for permanent pasture. This map unit is not suited to crops and is poorly suited to hay and pasture. Very steep slopes limit the use of machinery. Very steep slopes, the erosion hazard, and poor forage production severely limit the use of these soils for pasture.

Areas of this map unit used for woodland wildlife should be managed to protect the existing habitat and to maintain or improve its quality. Management for wildlife habitat also enhances the scenic value of these areas.

This map unit is generally unsuitable for buildings, roads, or septic tank absorption fields because it has very steep slopes. Soils that are more suitable for these uses are generally nearby.

This Etter-Brodale complex is in capability subclass VIIs.

1902B—Jewett silt loam, 1 to 6 percent slopes. This undulating, well drained soil is on side slopes and hill crests on end moraines. Individual areas are irregular in shape and range from about 5 to 30 acres.

Typically, the surface layer is very dark brown silt loam about 4 inches thick. The subsurface layer is brown silt loam about 9 inches thick. The subsoil is about 20 inches thick. The upper part is yellowish brown silt loam, and the lower part is dark brown loam. The underlying material to a depth of about 60 inches is reddish brown sandy loam. In some places, the silt loam is more than 30 inches thick.

Included with this soil in mapping are a few small areas of the Antigo, Kingsley, and Spencer soils. The Antigo soil has more sand in the substratum than the Jewett soil. The Kingsley soil has a sandy loam surface layer. The Spencer soil is moderately well drained and is similar in position to the Jewett soil. These soils make up 5 to 15 percent of the map unit.

The permeability of the Jewett soil is moderate. The available water capacity is high, and runoff is medium. The reaction is slightly acid to very strongly acid in the subsoil. The organic matter content is moderate.

This soil is well suited to cultivated crops. Erosion is the main management concern. Using minimum tillage, returning crop residues to the soil, and including hay crops in the rotation minimize erosion. Contour farming is difficult because of the short, irregular slopes.

This soil is well suited to pasture and hay. Including legume and grass forage in the cropping system reduces erosion, builds up nitrogen in the soil, and improves tilth for future crops. Proper stocking, pasture rotation, and timely deferment of grazing help to maintain the most productive plants.

This soil is well suited to woodland. Most trees grow well if competing vegetation is controlled. Controlling

weeds, cultivating crops, and applying herbicides help to control competing plants.

If buildings are constructed on this soil, foundations and footings should be designed to prevent structure damage caused by shrinking and swelling of the soil. Backfilling around foundations with a suitable coarse material provides added protection against structure damage. Constructing roads on well-compacted, coarse textured base material helps protect them from damage caused by frost action and shrinking and swelling. The moderate permeability of this soil restricts its use for septic tank absorption fields, but this limitation can be reduced by installing a larger than average drainage field.

This Jewett soil is in capability subclass IIe.

prime farmland

Prime farmland is one of several kinds of important farmlands defined by the U.S. Department of Agriculture. It is defined as the land best suited to producing food, feed, forage, fiber, and oilseed crops. When treated and managed according to acceptable farming methods, it has the soil quality, growing season, and moisture supply needed to produce a sustained high yield of crops. These high yields are produced with minimal expenditure of energy and economic resources, and farming this land results in the least damage to the environment.

Because the supply of high-quality farmland is limited, responsible individuals, as well as government, must encourage and facilitate its use in meeting the Nation's short- and long-range needs for food and fiber (fig. 15). Prime farmland may now be in cropland, pasture, woodland, or anything other than urban and built-up land or water areas. It must either be used for producing food or fiber or be available for such use.

Prime farmland usually has an adequate and dependable supply of moisture from precipitation or

Figure 15.—Agricultural land is being preserved on the fertile Waukegan soils in the foreground. The less fertile, more rolling Kingsley soils in the background are used for urban development.

irrigation. It also has a favorable temperature and growing season and acceptable levels of acidity or alkalinity. It has few or no rocks and is permeable to water and air. Prime farmland is not excessively erodible or saturated for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. For more detailed information on the criteria for prime farmland consult the local staff of the Soil Conservation Service.

About 200,400 acres, or nearly 54 percent of Dakota County meets the soil requirements for prime farmland. Areas are scattered throughout the county, but most are in the southern part, mainly in map units 2, 4, 5, 6, 7, and 8 of the general soil map. Approximately 160,300 acres of this prime farmland is used for crops.

A recent trend in land use in some parts of the county has been the loss of prime farmland to industrial and urban uses. This loss of prime farmland puts pressure on marginal lands, which are farmed although they generally are more erodible, droughty, and difficult to cultivate and usually are less productive.

Following is a list of soil map units that make up prime farmland in Dakota County. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps in the back of this publication. The soil qualities that affect use and management are described in the section "Detailed soil map units."

Soils that have limitations—a high water table, flooding, or inadequate rainfall—may qualify as prime farmland if these limitations are overcome by such measures as drainage, flood control, or irrigation. In the following list, the measures used to overcome these limitations, if any, are shown in parentheses after the map unit name. Onsite evaluation is necessary to see if these limitations have been overcome by corrective measures.

2B Ostrander loam, 1 to 6 percent slopes
27A Dickinson sandy loam, 0 to 2 percent slopes
27B Dickinson sandy loam, 2 to 6 percent slopes
39A Wadena loam, 0 to 2 percent slopes
39B Wadena loam, 2 to 6 percent slopes
39B2 Wadena loam, 2 to 6 percent slopes, eroded
49B Antigo silt loam, 1 to 8 percent slopes
98 Colo silt loam, occasionally flooded (where drained)
106B Lester loam, 2 to 6 percent slopes
109 Cordova silty clay loam (where drained)
113 Webster clay loam (where drained)
129 Cylinder loam
150B Spencer silt loam, 2 to 6 percent slopes
176 Garwin silty clay loam (where drained)
203B Joy silt loam, 1 to 5 percent slopes
208 Kato silty clay loam (where drained)
213B Klinger silt loam, 1 to 5 percent slopes
226 Lawson silt loam
239 Le Sueur loam
250 Kennebec silt loam
252 Marshan silty clay loam (where drained)
253 Maxcreek silty clay loam (where drained)
255 Mayer silt loam (where drained)
279B Otterholt silt loam, 1 to 6 percent slopes
285A Port Byron silt loam, 0 to 2 percent slopes
285B Port Byron silt loam, 2 to 6 percent slopes
299A Rockton loam, 0 to 2 percent slopes
299B Rockton loam, 2 to 6 percent slopes
301B Lindstrom silt loam, 1 to 4 percent slopes
313 Spillville loam, occasionally flooded
320B Tallula silt loam, 2 to 6 percent slopes
342B Kingsley sandy loam, 3 to 8 percent slopes
377B Merton silt loam, 1 to 6 percent slopes
378 Maxfield silty clay loam (where drained)
382B Blooming silt loam, 1 to 6 percent slopes
411A Waukegan silt loam, 0 to 1 percent slopes
411B Waukegan silt loam, 1 to 6 percent slopes
414 Hamel silt loam (where drained)
449B Crystal Lake silt loam, 1 to 8 percent slopes
463 Minneiska loam, occasionally flooded
1816 Kennebec Variant silt loam
1827A Waukegan silt loam, bedrock substratum, 0 to 2 percent slopes
1827B Waukegan silt loam, bedrock substratum, 2 to 6 percent slopes
1894B Winnebago loam, 2 to 6 percent slopes
1895B Carmi loam, 2 to 8 percent slopes
1896B Ostrander-Carmi loams, 2 to 6 percent slopes
1902B Jewett silt loam, 1 to 6 percent slopes

This page intentionally left blank.

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 and potentials 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 potentials and 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

General management needed for crops and pasture is suggested in this section. 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.

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 Agricultural Extension Service.

Some basic management is needed for nearly all of the soils that are used for crops and pasture. The following paragraphs discuss basic practices needed for controlling erosion, providing drainage, preserving tilth, maintaining fertility, and conserving moisture. Technical assistance in planning and applying practices suitable for the soils on a particular farm can be obtained from a local representative of the Soil Conservation Service.

Water erosion is a hazard on the sloping soils. Silty soils, such as the Waukegan and Tallula soils are particularly susceptible. To control water erosion, it is necessary to reduce runoff and increase the water intake. Among the practices that help to control erosion are contour cultivation, terracing, stripcropping, minimum tillage, grassed waterways, and proper use of crop residue. A high content of organic matter and high level of fertility increase the infiltration of water and enable the soil to support crops that improve the soil structure. On livestock farms, which require pasture and hay, including legume and grass forage in the cropping system reduces erosion and builds up nitrogen in the soil for the following crop.

Soil blowing occurs throughout the survey area but is less serious than water erosion. It is more severe on the sandy soils in the eastern part of the survey area and on the organic soils that have been drained and are cultivated. The Hubbard, Plainfield, and Sparta soils are examples of sandy soils, and the Boots, Palms, and Seelyeville soils are examples of the organic soils. Soil blowing in these areas can be controlled by maintaining a cover of plants or crop residue and by conservation tillage, stripcropping, and the use of field windbreaks to protect the exposed areas. Areas subject to soil blowing need a cropping system that provides a cover of residue in the winter and early in the spring when soil blowing is most likely to occur.

Drainage is needed for intensive cropping of wet, level or depressional soils. Tile drains function well in some areas of the county, for example on the Colo, Glencoe, and Webster soils. Surface ditches may be adequate to remove the surface water in some areas. In areas that are underlain by sandy or gravelly material, such as the poorly drained Kato and Mayer soils, it is difficult to install tile drains and to maintain open drains.

Root development is good on adequately drained soils because the movement of air and water through the soil is not restricted. Soils that are adequately drained generally warm up earlier in the spring. Effective drainage permits more timely operations.

Frequent tillage or tilling when the soil is too wet or too dry damages the structure of the soil. Frequent tillage when the soil is too dry makes the surface layer powdery, and water is not absorbed readily. This increases the amount of moisture available to the plants and also increases the hazard of erosion. Tilling when the soil is too wet makes the surface layer cloddy and undesirable as a seedbed. Tillage should be minimized to prepare a good seedbed, to control weeds, and to control the growth of crops from the previous year. The amount of tillage needed can also be reduced by applying chemicals to control weeds.

Fall plowing is a common practice. Tillage other than rough plowing should be avoided in the fall. A rough surface holds the moisture from melting snow and reduces the hazard of erosion. Freezing and thawing of the soil in winter help break up the clods and make tillage easier in the spring. Soils plowed in the fall can be tilled earlier in the spring. As a result, a better seedbed is generally prepared, and the potential for a good stand of plants is increased.

Sloping soils can be protected from excessive soil loss by using minimum tillage and rough tillage and by properly managing all crop residue. These practices help to control erosion and provide a better seedbed for crops that are adapted to minimum tillage. Wherever possible, sloping soils should be cultivated on the contour. Fall plowing is suitable if such soils are terraced and if manure or some other protective mulch is used.

The soils in Dakota County vary widely in their need for lime and fertilizer, depending on the natural acidity of the soils, the previous management, and the cropping system. It is best to have the soils tested once during the cropping system, or about every 3 to 5 years, to determine the need for lime and fertilizer. Tests should be conducted by a reliable laboratory that provides an analysis and interprets the results.

Effective practices on droughty, sandy soils are mainly those that conserve moisture. This generally means controlling wind erosion, limiting runoff, increasing infiltration, and controlling weeds. Measures that help are field windbreaks, stripcropping, minimum tillage, maximum use of crop residue, and planting of early maturing crops.

irrigation

Fred Bergsrud, extension agricultural engineer, University of Minnesota, and Lowell D. Hanson, extension soil resource specialist, assisted in the writing of this section.

The irrigated acreage of Dakota County soils has increased dramatically from approximately 3,000 acres in 1970 to an estimated 45,000 acres in 1979. All of the irrigation is done with sprinkler systems with the exception of small acreages of truck crops, nursery stock, or orchards that use drip or trickle systems. Two types of systems, the center pivot and traveling gun, are mainly in use. It is estimated that in 1979 they were being used on over 90 percent of the acreage.

A center pivot system operates on a quarter section (square, 160-acre tract), irrigating approximately 135 acres. It is nozzled to deliver approximately 900 gallons per minute with a pivot pressure of 75 to 80 pounds per square inch (psi), and it completes an irrigation cycle, or revolution, in three days. If an application efficiency of 85 percent is assumed, the typical operation results in a net application of 0.9 inch of water per revolution. Corner systems, which feature special modifications to irrigate the corners of the fields are increasing in popularity as are low-pressure systems, which operate with pivot pressures of 40 to 60 psi.

A typical traveling gun irrigation system operates on a rectangular, 80-acre field. It delivers 550 gallons per minute through a single nozzle at a nozzle pressure of 90 psi. The system moves across the field in travel lanes spaced 250 to 300 feet apart. Water is supplied by a hose 4 1/2 inches in diameter and 660 feet long. It normally irrigates 1,320 feet in 10 to 11 hours. The net amount of water applied per irrigation varies from 1.0 to 1.25 inches.

Typical pumping plants for irrigation systems consist of a multistage turbine pump driven by a vertical hollowshaft electric motor, or by a diesel engine and right-angle gearhead. Aluminum pipe is most commonly used for above ground applications and plastic pipe is used for buried mainlines.

Ground water predominates as a water source. Surface water from streams or rivers is used to supply a small part of the systems. Most of the irrigation wells in the county are completed in bedrock aquifers, principally the Jordan. The exception would be in the Randolph-Cannon Falls area where a number of wells are completed in sand and gravel aquifers. The average well completed in the bedrock aquifers is 300 feet deep. Wells completed in surficial sand and gravel aquifers may be as shallow as 30 feet, and those in buried sand and gravel aquifers are about 100 feet deep.

The amount of water required for irrigation varies with the seasonal rainfall and its distribution and with the type of soil. A minimum of 3 to 4 inches is needed in wet years on the soils with high available moisture capacity, and up to 18 or 20 inches is needed in extremely dry years on the droughtiest soils. Averages would likely range between 6 and 9 inches for Dakota County.

Water quality is not normally a factor when irrigating from a ground-water source in Dakota County. Surface water, such as a river that may receive effluent from a city or industry, should be checked for potential problems before being used as a source of irrigation water.

Land with slopes of 2 percent or less is best suited to sprinkler irrigation systems, and most of the soils in Dakota County are of this type. The three main sandy substratum soils are in the Rosemount-Farmington area, the Hastings area, and an area east and west of Randolph and north of the Cannon River. Erosion is increasingly a problem, however, on some of the sandy soils and other finer textured soils that benefit from irrigation but have slopes of more than 2 percent. Irrigation equipment will operate on slopes of more than 10 percent, but to prevent excessive erosion, irrigation should be limited to slopes of 6 percent or less. Somewhat steeper land might be irrigated if extensive conservation practices are used.

Minimum tillage, contour farming, or cross-slope farming should be used to reduce erosion. Management should involve irrigation scheduling and operation of the irrigation equipment to reduce erosion. In general, water should be applied on sloping land only when there is vegetative cover and at a rate that does not exceed the infiltration rate of the soil.

The hazard of pollution of surface or ground water is not increased by irrigation. However, if excessive nitrogen fertilizer is used on crops in combination with irrigation, some leaching of water soluble nitrates can occur. If these nitrates move downward to an aquifer, pollution of the ground water occurs. To minimize this problem, the amount of nitrogen fertilizer used should be based on recommendations from soil tests and past crop history. Research on corn has demonstrated that splitting the nitrogen into two to four applications rather than applying it all in the spring increases efficiency markedly. A split application of nitrogen before planting in late June or July is, therefore, recommended on irrigated corn. Irrigation scheduling to prevent an excessive application of water also helps minimize nitrogen leaching. The other fertilizer elements, phosphorus and potassium, do not pose a pollution hazard if incorporated in the soil.

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 Agricultural Extension Service can provide information about the management and productivity of the soils.

land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. 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 grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider 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."

woodland management and productivity

Dakota County is within the northern deciduous forest region and is primarily covered with forest types of northern upland hardwoods and oak. Native trees are quaking aspen, northern red oak, white oak, sugar maple, American elm, American basswood, and black cherry.

Originally the northern third of Dakota County was forested. The remaining areas were grassland with scattered tracts of timber, which consisted mainly of oak and elm.

The river-bottom hardwood forest type is along the flood plains of the Mississippi River. It consists of eastern cottonwood, black ash, green ash, American elm, willow, and hackberry.

The woodland in the county is now in small tracts. Trees are similar to the original forest types, but wood production is limited. Many areas are used for homesites and recreation, and some are grazed.

Table 6 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination (woodland suitability) symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: x, w, t, d, c, s, f, and r.

In table 6, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *windthrow hazard* are based on soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that a few trees may be blown down by normal winds; *moderate*, that some trees will be blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

woodland understory vegetation

Understory vegetation consists of grasses, forbs, shrubs, and other plants. Some woodland, if well managed, can produce enough understory vegetation to support grazing of livestock or wildlife, or both, without damage to the trees.

The quantity and quality of understory vegetation vary with the kind of soil, the age and kind of trees in the canopy, the density of the canopy, and the depth and condition of the litter. The density of the canopy determines the amount of light that understory plants receive.

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, hold 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 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 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 Agricultural Extension Service or from a nursery.

recreation

The many lakes and streams, the wooded hills, and the picturesque scenery in Dakota County provide ample opportunity for recreational development. Ideal picnic areas, campsites, and scenic overlooks are along the major rivers in the county. Numerous sites important to early Minnesota history are in Dakota County. The many lakes in the survey area are used for boating, swimming, and fishing.

Numerous county and city parks provide picnic areas, hiking trails, biking trails, beaches, and other recreational facilities. The Fort Snelling State Park offers a wide range of recreational facilities from camping and picnic areas to cross-country skiing and snowmobile trails. Some of the rolling hills throughout the survey area are well suited to development of ski and toboggan runs. Buck Hill is well known in the area for excellent skiing facilities.

City dwellers in increasing numbers are turning to outdoor recreation. Consequently, owners of farms, woodlands, and lakeshore property have an opportunity to develop new and potentially profitable enterprises, such as facilities for camping, hiking, skiing, fishing, hunting, golfing, and other forms of outdoor recreation.

The soils of the survey area are rated in table 8 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 8, 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 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

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, horseback riding, and bicycling 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 Dakota County have the potential to provide good habitat for various kinds and species of wildlife. This county is in the transitional area for several major wildlife species. The number of animals of any one species may not be as high as in more favored parts of the animal's range. In most of the northern third of Dakota County, the natural habitat of many species of wildlife has been changed or destroyed by urbanization.

The principal wildlife in Dakota County are several species of migratory waterfowl; mink, muskrat, and other small furbearing animals that inhabit wetlands; grouse, pheasant, and other upland game birds; rabbit, fox, squirrel, and other small mammals; and deer.

Many of the lakes in the survey area, mainly Spring, Orchard, Marion, and Byllesby Lakes, provide good fishing. The principal sport fish are northern pike and pan fish, such as bluegill, crappie, and sunfish. The Minnesota, Mississippi, and Cannon Rivers provide good fishing for walleye, bass, crappie, and catfish.

Wildlife populations can be increased by rotating crops, planting crops in strips, and seeding ditchbanks and field borders to provide a variety of cover that is attractive and beneficial to wildlife. Improving farmstead windbreaks and seeding odd areas to grasses, legumes, shrubs, and trees provide food and cover for many species of wildlife.

Scattered areas in the urban part of Dakota County are left undeveloped because of severe limitations to urban uses. These areas produce and shelter large numbers of waterfowl and pheasants. Hunting this wildlife is restricted in many areas.

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 9, 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, 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, goldenrod, wheatgrass, and grama.

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, the available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, apple, hawthorn, dogwood, and hickory. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and crabapple.

Coniferous plants furnish browse, seeds, and cones. 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, wildrice, saltgrass, cordgrass, 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 bobwhite quail, pheasant, meadowlark, field sparrow, 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 wild turkey, ruffed grouse, 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, shore birds, muskrat, mink, 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, 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 (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) 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 10 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 11 shows the degree and the 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 11 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 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 effectively filter the effluent. 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 11 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 11 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 excess 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 12 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 12, 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 13 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 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 of 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.

This page intentionally left blank.

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 14 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 a soil contains particles coarser than sand, 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 oven-dry 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 15 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 earth-moving 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.

Soil 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. Data in table 15 refer to reaction of the B horizon, and if the soil has no B horizon, they refer to part of the A and/or C horizons.

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 15, the estimated content of organic matter of the plow layer 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

Tables 16 and 17 give 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, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes are not considered flooding.

Table 16 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 16 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, 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 16.

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. An artesian water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. 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.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 17 shows the expected initial subsidence, which usually is a result of drainage, and annual subsidence, which usually is a result of oxidation.

Not shown in the table is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

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 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 (*8*). 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. In table 18, the soils of the survey area are classified according to the system. 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 Udoll (*Ud*, meaning humid, 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 Hapludolls (*Hapl*, meaning minimal horizonation, plus *udoll*, the suborder of the Mollisols that have a udic 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 Hapludolls.

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 Hapludolls.

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 (*6*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*8*). 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."

Algansee series

The Algansee series consists of deep, somewhat poorly drained soils on flood plains of major rivers. They are very rapidly permeable. These soils formed in sediments that are loamy in the upper part and sandy in the lower part. Slopes range from 0 to 2 percent.

The Algansee soils in Dakota County have a thicker dark surface layer than is defined as the range for the series. This difference does not alter the usefulness or behavior of the soils.

The Algansee soils are similar to the Zumbro soils and are commonly adjacent to the somewhat higher Colo,

Lawson, and Minneiska soils. Colo and Lawson soils are mostly higher on flood plains than the Algansee soils, and some Colo soils are in upland depressions. The Zumbro soils are generally on high bottoms or low terraces above the Algansee soils. The Minneiska soils are calcareous throughout the solum. The Colo, Lawson, and Zumbro soils have a thick, black surface layer.

Typical pedon of Algansee sandy loam, occasionally flooded, 1,500 feet east and 150 feet north of the southwest corner of sec. 23, T. 115 N., R. 17 W.

A—0 to 12 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; very friable; mildly alkaline; abrupt smooth boundary.
C1—12 to 18 inches; dark brown (10YR 4/3) sand; single grain; loose; mildly alkaline; abrupt smooth boundary.
C2—18 to 26 inches; dark yellowish brown (10YR 4/4) sand; few fine faint dark grayish brown (10YR 4/2) mottles; single grain; loose; mildly alkaline; abrupt smooth boundary.
C3—26 to 60 inches; dark brown (10YR 4/3) sand; few fine faint dark grayish brown (10YR 4/2) mottles; single grain; loose; mildly alkaline.

The reaction of the control section ranges from medium acid to mildly alkaline. The dominant textures from a depth of 10 to 40 inches are sand, fine sand, loamy sand, or loamy fine sand. Some pedons have thin strata of loam or sandy loam.

The A horizon has hue of 7.5YR or 10YR, value of 2 through 4, and chroma of 1 through 3. It is loamy sand, sand, or sandy loam. The C horizon has hue of 7.5YR or 10YR, value of 4 through 6, and chroma of 3 through 6. Mottles in the C horizon range from prominent to faint. Gravelly subhorizons are in some pedons below a depth of 40 inches.

Antigo series

The Antigo series consists of deep, well drained soils on pitted outwash plains and end moraines. They are moderately permeable in the upper part and rapidly permeable in the lower part. These soils formed in a silty mantle over sandy outwash material. Slopes range from 1 to 8 percent.

The Antigo soils in Dakota County do not have tongues of albic material in the upper part of the B horizon and have a higher base saturation than is defined as the range for the series. These differences do not alter the usefulness or behavior of the soils.

The Antigo soils are similar to the Otterholt soils and are commonly adjacent to the Mahtomedi and Otterholt soils. All three are similar in position on the landscape. The Mahtomedi soils formed in brown or reddish brown coarse textured outwash, and the Otterholt soils formed in a silty mantle underlain by sandy loam glacial till.

Typical pedon of Antigo silt loam, 1 to 8 percent slopes, 640 feet east and 1,020 feet south of the northwest corner of sec. 20, T. 115 N., R. 20 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; weak fine granular structure; very friable; slightly acid; abrupt smooth boundary.
BA—8 to 11 inches; dark brown (10YR 4/3) silt loam; weak fine subangular blocky structure; very friable; slightly acid; clear wavy boundary.
Bw—11 to 17 inches; yellowish brown (10YR 5/6) silt loam; moderate fine subangular blocky structure; very friable; slightly acid; clear wavy boundary.
Bt—17 to 24 inches; dark brown (7.5YR 4/4) silt loam high in content of clay; moderate medium subangular blocky structure; friable; few discontinuous clay films on faces of peds; slightly acid; abrupt smooth boundary.
2C1—24 to 40 inches; dark brown (7.5YR 4/4) sand; single grain; loose; about 10 percent coarse fragments; neutral; gradual smooth boundary.
2C2—40 to 60 inches; dark brown (7.5YR 4/4) sand; single grain; loose; about 5 percent coarse fragments; mildly alkaline.

The thickness of the solum ranges from 20 to 40 inches. The silty sediments in the upper part range from 20 to 36 inches.

The A horizon has value of 2 or 3 and chroma of 2 or 3. Some pedons have an E horizon with hue of 10YR, value of 4 through 6, and chroma of 2 or 3. The B horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 through 6. Texture is silt loam or silty clay loam. Reaction ranges from slightly acid to strongly acid. The 2C horizon has hue of 10YR or 7.5YR and value and chroma of 3 through 6. Texture ranges from fine sand to gravelly coarse sand. Coarse fragments range from 2 to 20 percent.

Auburndale series

The Auburndale series consists of deep, poorly drained soils on end moraines. They are moderately permeable and moderately slowly permeable. These soils formed in a silty mantle underlain by loamy glacial till. Slopes range from 1 to 3 percent.

The Auburndale soils in Dakota County do not have tongues of albic material in the B horizon and have a higher base saturation than is defined as the range for the series. These differences do not alter the usefulness or behavior of the soils.

The Auburndale soils are commonly adjacent to the slightly higher Jewett, Kingsley, and Spencer soils. The Jewett and Kingsley soils are well drained, and the Kingsley soils have more coarse fragments and sand in the solum. The Spencer soils are moderately well drained.

Typical pedon of Auburndale silt loam, 1,000 feet east and 600 feet south of the northwest corner of sec. 31, T. 27 N., R. 23 W.

A1—0 to 3 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; weak fine granular structure; very friable; medium acid; clear wavy boundary.
A2—3 to 13 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; few fine distinct brownish yellow (10YR 6/6) mottles; weak fine subangular blocky structure; very friable; medium acid; abrupt smooth boundary.
E1—13 to 17 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; few fine distinct strong brown (7.5YR 5/6) mottles; weak very thin platy structure; very friable; medium acid; clear wavy boundary.
E2—17 to 25 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; few fine distinct strong brown (7.5YR 5/6) mottles; weak medium platy structure parting to weak fine angular blocky; very friable; slightly acid; clear wavy boundary.
Btg—25 to 36 inches; grayish brown (10YR 5/2) silt loam; common fine distinct strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; few discontinuous clay films on faces of peds; friable; strongly acid; clear wavy boundary.
Cg—36 to 58 inches; grayish brown (10YR 5/2) silt loam; few fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; medium acid; clear wavy boundary.
2C1—58 to 60 inches; dark brown (7.5YR 4/4) sandy loam; massive; friable; slightly acid.

The thickness of the solum typically is 30 to 40 inches but ranges from 30 to 48 inches. The silty sediments are from 30 to 60 inches thick.

The A1 or Ap horizon has value of 2 or 3 and chroma of 1 or 2. The E horizon has value of 4 through 6 and chroma of 1 or 2. It has few to many, faint to prominent mottles. The B horizon has hue of 7.5YR, 10YR, or 2.5Y; value of 4 through 6; and chroma of 1 or 2. It has common to many, distinct to prominent mottles. Reaction ranges from strongly acid to medium acid. The C1 horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 2 to 4. It has few fine mottles with hue of 10YR or 7.5YR. The 2C horizon has hue of 7.5YR or 5YR and value and chroma of 4 through 6. Coarse fragments range from 0 to 35 percent, by volume.

Blooming series

The Blooming series consists of deep, well drained soils on uplands and end moraines. They are moderately permeable. These soils formed in a thin, silty mantle underlain by loamy, calcareous glacial till. Slopes range from 1 to 6 percent.

The Blooming soils are similar to the adjacent Lester soils and are commonly higher than the adjacent Le Sueur and Merton soils. The Lester soils are similar to the Blooming soils but have a thinner silty mantle. The Le Sueur and Merton soils are moderately well drained to somewhat poorly drained.

Typical pedon of Blooming silt loam, 1 to 6 percent slopes, 930 feet east and 30 feet north of the southwest corner of sec. 3, T. 112 N., R. 20 W.

Ap—0 to 9 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; neutral; abrupt smooth boundary.
Bt1—9 to 16 inches; dark brown (10YR 4/3) silty clay loam; weak fine subangular blocky structure; friable; very few thin clay films on vertical faces of peds; medium acid; clear wavy boundary.
2Bt2—16 to 21 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium subangular blocky structure; friable; continuous thin dark brown (10YR 4/3) clay films on vertical faces of peds; medium acid; abrupt wavy boundary.
2Bt3—21 to 28 inches; dark yellowish brown (10YR 4/4) sandy clay loam; moderate medium subangular blocky structure; friable; few thin clay films in root channels; 3 percent coarse fragments; medium acid; clear wavy boundary.
2Bt4—28 to 36 inches; dark yellowish brown (10YR 4/4) sandy clay loam; moderate medium subangular blocky structure; friable; continuous thin dark brown (10YR 3/3) clay films on faces of peds; 5 percent coarse fragments; medium acid; clear wavy boundary.
2Bt5—36 to 40 inches; yellowish brown (10YR 5/4) sandy clay loam; weak medium subangular blocky structure; friable; few thin dark brown (10YR 4/3) clay films in root channels; 5 percent coarse fragments; medium acid; clear wavy boundary.
2BtC—40 to 48 inches; yellowish brown (10YR 5/4) sandy clay loam; weak coarse subangular blocky structure; friable; few thin dark brown (10YR 4/3) clay films in root channels; 5 percent coarse fragments; slightly acid; clear wavy boundary.
2C—48 to 60 inches; light olive brown (2.5Y 5/4) fine sandy loam; massive; friable; 5 percent coarse fragments; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 35 to 65 inches. The silty sediments are 14 to 24 inches thick and are less than 1 percent coarse fragments. The lower glacial material generally is 2 to 6 percent coarse fragments, but in many pedons the upper 12 inches or less do not have coarse fragments.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is generally silt loam, but loam is within the range.

Some pedons have an E horizon about 4 inches thick. The matrix of the upper part of the B horizon has value of 4 or 5 and chroma of 3 or 4, and the matrix of the lower part of the B horizon has 10YR or 2.5Y hue, value of 4 or 5, and chroma of 3 through 5. Some pedons have a few mottles in the lower part of the B horizon. The Bt horizon is silt loam or silty clay loam, and the 2Bt horizon is loam, clay loam, or sandy clay loam. The B horizon ranges from slightly acid to medium acid. The 2C horizon has chroma of 4 through 6. It is loam, fine sandy loam, or sandy loam.

Bold series

The Bold series consists of deep, well drained soils on uplands. These are moderately permeable soils that formed in loess. Slopes range from 6 to 25 percent.

The Bold soils are mapped only in complex with the similar Timula soils. The Bold soils are commonly adjacent to the Port Byron, Tallula, and Timula soils. The Port Byron soils have more clay in the solum, the Tallula soils have a mollic epipedon, and the Timula soils have a cambic horizon. These soils are all in similar positions on the landscape.

Typical pedon of Bold silt loam from an area of Timula-Bold silt loams, 12 to 18 percent slopes, 1,600 feet south and 500 feet west of the northeast corner of sec. 13, T. 113 N., R. 18 W.

Ap—0 to 8 inches; yellowish brown (10YR 5/4) silt loam, light yellowish brown (10YR 6/4) dry; weak medium subangular structure parting to weak fine granular; very friable; mildly alkaline; abrupt smooth boundary.

C—8 to 60 inches; yellowish brown (10YR 5/4) silt loam; few fine to medium distinct yellowish brown (10YR 5/8) mottles; massive; very friable; strong effervescence; mildly alkaline.

The thickness of the solum, which is the same as the A1 or Ap horizon, ranges from 6 to 10 inches. The A horizon has value of 4 through 6 and chroma of 1 through 6. The C horizon generally has multicolored mottles. Reaction is mildly or moderately alkaline.

Boone series

The Boone series consists of moderately deep, excessively drained soils on uplands. They are rapidly permeable. These soils formed in sandy residuum weathered from sandstone bedrock. Slopes range from 2 to 40 percent.

The Boone soils are commonly adjacent to the Etter, Ostrander, and Rockton soils that are lower on the landscape. The Etter soils have more clay in the solum. The Ostrander soils formed in silty-mantled, loamy glacial till. The Rockton soils have an argillic horizon and are on landscapes controlled by limestone bedrock.

Typical pedon of Boone loamy fine sand, 2 to 6 percent slopes, 990 feet west and 660 feet south of the northeast corner of sec. 13, T. 114 N., R. 19 W.

A—0 to 3 inches; brown (10YR 5/3) loamy fine sand, light brownish gray (10YR 6/2) dry; single grain; loose; slightly acid; abrupt smooth boundary.

AC—3 to 8 inches; yellowish brown (10YR 5/4) loamy fine sand, pale brown (10YR 6/3) dry; single grain; loose; slightly acid; clear wavy boundary.

C—8 to 24 inches; white (10YR 8/1) fine sand with multicolored strata; single grain; loose; slightly acid; clear wavy boundary.

Cr—24 to 60 inches; white (10YR 8/1) fine sand; weakly cemented; slightly acid.

Sandstone bedrock is at a depth of 20 to 40 inches. The sandstone is a paralithic contact, but in many places it is hard enough to be a lithic contact. Reaction in the solum ranges from strongly acid to slightly acid. Coarse fragments smaller than 3 inches range from 0 to 15 percent, by volume. The A horizon has value of 3 through 5 and chroma of 1 through 3. It is loamy fine sand, loamy sand, fine sand, or sand. The C horizon has hue of 10YR or 7.5YR, value of 4 through 8, and chroma of 1 through 6. It is sand or fine sand.

Boots series

The Boots series consists of deep, very poorly drained soils on the Minnesota River flood plain and on end moraines. They are moderately permeable. These soils formed in moderately decomposed organic material more than 51 inches thick. Slopes range from 0 to 2 percent.

The Boots soils are similar to Seelyeville soils and are commonly adjacent to the Palms and Seelyeville soils. Highly decomposed organic material is dominant in the organic layers of the Palms and Seelyeville soils. The Palms soils contain loamy mineral deposits above 51 inches. The Palms and Seelyeville soils are similar to the Boots soils in position on the landscape.

Typical pedon of Boots muck, 480 feet east and 710 feet south of the northwest corner of sec. 4, T. 28 N., R. 23 W.

Oa—0 to 5 inches; black (10YR 2/1) rubbed sapric material; massive; friable; 20 percent fiber content, 3 percent rubbed; 25 percent mineral content; strong effervescence; mildly alkaline; clear smooth boundary.

Oe1—5 to 26 inches; very dark grayish brown (10YR 3/2) rubbed hemic material; massive; friable; 55 percent fiber content, 35 percent rubbed; 25 percent mineral content; strong effervescence; mildly alkaline; clear smooth boundary.

Oe2—26 to 60 inches; very dark grayish brown (10YR 3/2) rubbed hemic material; massive; friable; 55 percent fiber content, 35 percent rubbed; 15 percent mineral content; strong effervescence; mildly alkaline.

Some pedons contain up to 5 percent, by volume, woody fragments that cannot be crushed between the fingers. Reaction within the control section is neutral or mildly alkaline. In some pedons thin layers are as much as 30 percent mineral material. The layers in the subsurface and bottom tiers have 10YR or 7.5YR hue, value of 2 or 3, and chroma of 1 through 3. The layers in the surface tier are mainly sapric material; but in some pedons, they are hemic material. In some pedons, layers of sapric materials within the subsurface and bottom tiers total less than 10 inches in thickness.

Brodale series

The Brodale series consists of deep, excessively drained soils on uplands. They are moderately rapidly permeable. These soils formed in loamy colluvium and residuum from limestone bedrock. Slopes range from 18 to 60 percent.

The Brodale soils are commonly adjacent to the Copaston, Frontenac, Marlean, and Rockton soils. The Copaston and Rockton soils are generally on crests of slopes above the Brodale soils, and the Frontenac soils are on north- to east-facing slopes. The Copaston soils have level-bedded limestone within 20 inches of the surface. The Frontenac soils have fewer coarse fragments in the solum than the Brodale soils. The Marlean soils have no carbonates in the solum and are less sloping than the Brodale soils. The Rockton soils have an argillic horizon.

Typical pedon of Brodale flaggy loam in an area of Brodale-Rock outcrop complex, 18 to 45 percent slopes, 670 feet west and 980 feet south of the northeast corner of sec. 32, T. 114 N., R. 16 W.

A1—0 to 6 inches; very dark grayish brown (10YR 3/2) flaggy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; 40 percent coarse fragments; slight effervescence; moderately alkaline; abrupt wavy boundary.

Bw—6 to 10 inches; dark yellowish brown (10YR 4/4) flaggy very fine sandy loam; massive; friable; 50 percent coarse fragments; strong effervescence; moderately alkaline; clear wavy boundary.

C—10 to 47 inches; yellowish brown (10YR 5/4) very flaggy very fine sandy loam; massive; friable; 70 percent coarse fragments; strong effervescence; moderately alkaline; abrupt wavy boundary.

R—47 inches; limestone bedrock.

The thickness of the solum ranges from 8 to 20 inches, and depth to limestone bedrock ranges from 40 to 80 inches or more. Coarse fragments in the soil average 35 to 70 percent; however, the subhorizons in some pedons have less than 35 percent coarse fragments. These fragments are dominantly limestone. Generally, the fragments are flagstones, but in many pedons channers or cobbles are dominant. Textures in the fine earth fraction throughout the profile are sandy loam, very fine sandy loam, loam, and silt loam. However, the texture of the subhorizons in some pedons is loamy sand.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The B horizon has value of 4 or 5 and chroma of 3 through 5. Reaction is mildly alkaline or moderately alkaline. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 3 through 6.

Burkhardt series

The Burkhardt series consists of deep, somewhat excessively drained soils on uplands. They are moderately rapidly permeable in the upper part and rapidly permeable in the lower part. These soils formed in noncalcareous loamy sediments over sandy and gravelly deposits. Slopes range from 6 to 18 percent.

The Burkhardt soils are similar to the Hawick soils and are commonly adjacent to the Carmi and Estherville soils. The Hawick and Estherville soils formed in calcareous outwash. They are similar to the Burkhardt soils in position on the landscape. The Carmi soils formed in loamy sediments underlain by stratified glacial drift and are less sloping than the Burkhardt soils.

Typical pedon of Burkhardt sandy loam, 6 to 12 percent slopes, 700 feet east and 400 feet south from the center of sec. 16, T. 113 N., R. 18 W.

A—0 to 7 inches; very dark brown (10YR 2/2) sandy loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.

AB—7 to 12 inches; dark brown (7.5YR 3/2) sandy loam mixed with some dark reddish brown (5YR 3/4) subsoil material, dark brown (7.5YR 4/2) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; slightly acid; clear smooth boundary.

Bw—12 to 16 inches; dark reddish brown (5YR 3/4) sandy loam; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; slightly acid; abrupt smooth boundary.

BC—16 to 22 inches; dark reddish brown (5YR 3/4) gravelly sandy loam; weak very fine subangular blocky structure; friable; about 40 percent coarse fragments; slightly acid; abrupt smooth boundary.

2C1—22 to 49 inches; reddish brown (5YR 4/4) yellowish red (5YR 4/6) and strong brown (7.5YR 5/6) gravelly coarse sand; single grain; loose; about 15 percent coarse fragments; slightly acid; abrupt smooth boundary.
2C2—49 to 60 inches; yellowish red (5YR 4/6) gravelly coarse sand; single grain; loose; about 30 percent coarse fragments; slightly acid.

The thickness of the solum ranges from 12 to 24 inches. The thickness of the mollic epipedon ranges from 7 to 17 inches.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 1 through 3. It is loam or sandy loam and is 0 to 2 percent coarse fragments. The Bw horizon has hue of 7.5YR, 10YR, or 5YR; value of 3 or 4; and chroma of 2 to 4. It is sandy loam or loam and is 0 to 8 percent coarse fragments. Reaction is medium acid or slightly acid. The BC horizon is 8 to 40 percent coarse fragments. The C horizon has hue of 10YR, 7.5YR, or 5YR; value of 4 or 5; and chroma of 4 through 6. It is sand, coarse sand, gravelly sand, or gravelly coarse sand and is 15 to 40 percent coarse fragments.

Carmi series

The Carmi series consists of deep, well drained soils on uplands. They are moderately rapidly permeable in the upper part and rapidly permeable in the lower part. These soils formed in loamy sediments and the underlying stratified glacial drift. Slopes range from 2 to 8 percent.

The Carmi soils are similar to the Kingsley soils and are commonly adjacent to the Dickinson, Klinger, Ostrander, and Winnebago soils. They are similar in position to the Dickinson, Winnebago, and Ostrander soils. The Kingsley soils have a thinner surface layer and are on end moraines. The somewhat poorly drained Klinger soils are in drainageways. The Dickinson soils have less gravel in the control section; the Winnebago and Ostrander soils have more clay in the solum.

Typical pedon of Carmi loam, 2 to 8 percent slopes, 1,320 feet east and 120 feet north of center of sec. 34, T. 114 N., R. 17 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; friable; neutral; abrupt smooth boundary.
A—8 to 13 inches; very dark grayish brown (10YR 3/2) loam, dark brown (10YR 4/3) dry; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.
Bw—13 to 18 inches; dark yellowish brown (10YR 4/4) loam; weak medium subangular blocky structure; friable; medium acid; clear wavy boundary.
Bt—18 to 25 inches; dark brown (7.5YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; few, thin clay films on faces of peds; medium acid; abrupt wavy boundary.
2Bw1—25 to 30 inches; strong brown (7.5YR 5/6) loamy sand; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; medium acid; clear wavy boundary.
2Bw2—30 to 48 inches; dark brown (7.5YR 4/4) gravelly sandy loam; weak fine subangular blocky structure; friable; about 15 percent coarse fragments; medium acid; gradual wavy boundary.
2C—48 to 60 inches; yellowish red (5YR 4/6) gravelly loamy sand; massive; very friable; about 20 percent coarse fragments; strongly acid.

The thickness of the solum typically is 36 to 50 inches and ranges from 30 to 66 inches. The mollic epipedon is 10 to 22 inches thick. The thickness of the loamy mantle that generally is less than 5 percent coarse fragments and depth to material that is at least 15 percent coarse fragments range from 20 to 40 inches. The 2B horizon ranges from 2 to 20 percent or more coarse fragments. The 2C horizon is 15 percent to 70 percent coarse fragments.

The A horizon has value of 2 or 3 and chroma of 1 through 3. It generally is sandy loam, loam, or silt loam. The upper part of the B horizon has hue of 10YR or 7.5YR, value of 3 through 5, and chroma of 2 through 6. It is sandy loam, sandy clay loam, loam, or loamy sand. The 2B horizon has hue of 7.5YR or 5YR, value of 3 through 5, and chroma of 3 through 6. It is sandy loam, sandy clay loam, loamy sand, or their gravelly analogs. Reaction in the B and 2B horizons ranges from strongly acid to neutral. The 2C horizon has hue of 7.5YR or 5YR, value of 4 or 5, and chroma of 4 through 6. It is gravelly sandy loam, gravelly loamy sand, or gravelly sand.

Chetek series

The Chetek series consists of deep, somewhat excessively drained soils on pitted outwash plains and end morianes. They are moderately rapidly permeable in the upper part and rapidly permeable in the lower part. These soils formed in a thin loamy mantle and the underlying sandy sediments. Slopes range from 3 to 25 percent.

The Chetek soils in Dakota County do not have tongues of albic material in the upper part of the B horizon, have a darker colored A horizon, and have a higher base saturation than is defined as the range for the series. These differences do not alter the usefulness or behavior of the soils.

The Chetek soils are similar to the adjacent Estherville soils and to the Kingsley and Mahtomedi soils, which are in similar landscape positions. The Estherville soils have

a mollic epipedon. The Kingsley soils formed in sandy loam glacial till. The Mahtomedi soils have more sand in the surface horizon than the Chetek soils.

Typical pedon of Chetek sandy loam, 8 to 15 percent slopes, 1,500 feet west and 500 feet north of the center of sec. 13, T. 115 N., R. 20 W.

A—0 to 3 inches; very dark brown (10YR 2/2) sandy loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; friable; 2 percent coarse fragments; medium acid; clear wavy boundary.
AB—3 to 7 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; 5 percent coarse fragments; medium acid; clear wavy boundary.
Bt—7 to 14 inches; dark brown (7.5YR 4/4) loam; weak medium subangular blocky structure; friable; thin discontinuous clay films; 12 percent coarse fragments; medium acid; clear wavy boundary.
2BtC—14 to 24 inches; strong brown (7.5YR 5/6) gravelly loamy sand; single grain; loose; clay bridging of sand grains; 25 percent coarse fragments; medium acid; clear wavy boundary.
2C1—24 to 29 inches; strong brown (7.5YR 5/6) gravelly sand; single grain; loose; 20 percent coarse fragments; slightly acid; clear wavy boundary.
2C2—29 to 60 inches; yellowish brown (10YR 5/4) gravelly sand; single grain; loose; 15 percent coarse fragments; slightly acid.

The thickness of the solum ranges from 12 to 24 inches. The A horizon has hue of 10YR or 7.5YR, value of 2 through 4, and chroma of 2 or 3. Texture is loam or sandy loam. Some pedons have an E horizon that has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 or 3. The Bt horizon has hue of 7.5YR or 5YR and value and chroma of 3 or 4. Texture is sandy loam or loam, and reaction is slightly acid to strongly acid. The 2BtC horizon has hue of 10YR or 7.5YR and value and chroma of 4 through 6. It is gravelly sandy loam or gravelly loamy sand. Coarse fragments range from 15 to 35 percent, by volume. The 2C horizon has hue of 10YR, 7.5YR, or 5YR; value of 4 or 5; and chroma of 4 through 6. Texture is stratified gravelly loamy sand or gravelly sand and is 15 to 35 percent coarse fragments.

Colo series

The Colo series consists of deep, poorly drained soils on flood plains and in upland drainageways. They are moderately permeable, and they formed in noncalcareous alluvial sediments. Slopes range from 0 to 2 percent.

The Colo soils are similar to the Quam soils. They are commonly adjacent to the slightly higher Lawson soils on flood plains of major rivers and Garwin and Maxfield soils in the uplands. The very poorly drained Quam soils occupy closed depressions on end moraines. The Garwin soils have a thinner mollic epipedon than the Colo soils, the Lawson soils have less clay in the solum, and the Maxfield soils formed in loess and loamy glacial till.

Typical pedon of Colo silt loam, occasionally flooded, 0 to 2 percent slopes, 320 feet west and 680 feet south of the northeast corner of sec. 9, T. 114 N., R. 20 W.

A1—0 to 8 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; few fine distinct strong brown (7.5YR 5/6) mottles in root channels; weak medium granular structure; friable; medium acid; abrupt smooth boundary.
A2—8 to 20 inches; black (N 2/0) silt loam; black (10YR 2/1) dry; few fine distinct strong brown (7.5YR 5/6) mottles in root channels; weak fine subangular blocky structure; firm; slightly acid; gradual smooth boundary.
A3—20 to 26 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; firm; neutral; gradual smooth boundary.
A4—26 to 35 inches; black (10YR 2/1) silty clay loam, gray (10YR 5/1) dry; few fine distinct dark yellowish brown (10YR 4/6) mottles; weak fine subangular blocky structure; firm; neutral; diffuse smooth boundary.
A5—35 to 54 inches; very dark gray (N 3/0) silty clay loam, gray (10YR 5/1) dry; few fine distinct dark yellowish brown (10YR 4/6) mottles; weak fine subangular blocky structure; firm; neutral; diffuse smooth boundary.
C—54 to 60 inches; very dark gray (10YR 3/1) silty clay loam, dark brown (10YR 3/3) dry; few fine distinct strong brown (7.5YR 5/6) mottles; massive; firm; slightly acid.

The thickness of the solum ranges from 36 to 54 inches. The thickness of the mollic epipedon is 36 inches or more. Mottles of high chroma are throughout the profile but may be lacking in the upper 24 inches in some pedons. Reaction ranges from slightly acid to neutral. The thickness of stratified overwash sediments in some pedons is 18 inches but generally is 2 to 8 inches.

The A horizon has hue of 10YR, 5Y, or N; value of 2 or 3; and chroma of 0 or 1. Texture of the upper 10 inches of the A horizon is generally silt loam, but silty clay loam is within the range.

Copaston series

The Copaston series consists of shallow, well drained soils on terraces and uplands. They are moderately permeable to moderately rapidly permeable. These soils formed in a thin mantle of loamy glacial drift underlain by limestone bedrock. Slopes range from 0 to 12 percent.

The Copaston soils are commonly adjacent to the Brodale, Marlean, and Rockton soils. The Brodale soils are excessively drained and are on steep side slopes. The Marlean soils are underlain by about 12 feet of fragmented limestone and soft earthy material over hard, level-bedded limestone. They are downslope from the Copaston soils. The Rockton soils have an argillic horizon and are similar in landscape position to the Copaston soils.

Typical pedon of Copaston loam, 6 to 12 percent slopes, 50 feet east and 50 feet north of the southwest corner of sec. 26, T. 114 N., R. 17 W.

A—0 to 6 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; moderate fine and medium subangular blocky structure; friable; neutral; abrupt smooth boundary.
BA—6 to 10 inches; dark brown (10YR 3/3) loam, dark yellowish brown (10YR 4/4) dry; moderate fine and medium subangular blocky structure; friable; slightly acid; clear wavy boundary.
Bw—10 to 15 inches; dark yellowish brown (10YR 4/4) loam; moderate medium subangular blocky structure; friable; neutral; abrupt wavy boundary.
2R—15 inches; limestone bedrock.

The thickness of the solum and depth to bedrock range from 12 to 20 inches. Coarse fragments make up from 0 to 15 percent, by volume, of the solum. Limestone fragments are on the surface of some pedons.

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 and value and chroma of 3 or 4. It is sandy loam, fine sandy loam, or loam. Reaction ranges from slightly acid to mildly alkaline. The bedrock is mainly limestone, but in many pedons it is cemented sandstone. Typically, the boundary between the solum and the bedrock is abrupt, but in many pedons a thin layer of disintegrated rock less than 2 inches thick or discontinuous residuum is at the contact.

Cordova series

The Cordova series consists of deep, poorly drained soils on end moraines. They are moderately slowly permeable. These soils formed in silty sediments and in the underlying loamy glacial till. Slopes range from 0 to 2 percent.

The Cordova soils are similar to the Hamel and Webster soils and are commonly adjacent to the slightly higher Le Sueur soils and the Webster soils. The Hamel soils have a thicker mollic epipedon than the Cordova soils. The Webster soils do not have an argillic horizon. The Le Sueur soils are moderately well drained to somewhat poorly drained.

Typical pedon of Cordova silty clay loam, 1,260 feet south and 800 feet west of the northeast corner of sec. 22, T. 112 N., R. 20 W.

Ap—0 to 10 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; moderate medium granular structure; friable; slightly acid; abrupt smooth boundary.
A—10 to 16 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; moderate medium granular structure; friable; slightly acid; clear wavy boundary.
BgA—16 to 20 inches; very dark gray (5Y 3/1) loam, dark olive (5Y 3/2) dry; weak medium subangular blocky structure; friable; slightly acid; clear wavy boundary.
Btg1—20 to 26 inches; dark gray (5Y 4/1) clay loam; moderate medium subangular blocky structure; friable; few thin very dark gray (10YR 3/1) clay films on faces of peds; 2 percent coarse fragments; slightly acid; clear wavy boundary.
Btg2—26 to 34 inches; olive gray (5Y 4/2) clay loam; weak fine subangular blocky structure; friable; few thin very dark gray (5Y 3/1) clay films on faces of peds; 2 percent coarse fragments; slightly acid; clear wavy boundary.
C—34 to 60 inches; olive (5Y 5/3) loam; few fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; 4 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum and depth to free carbonates range from 24 to 50 inches. The mollic epipedon is 10 to 24 inches thick. Coarse fragments of mixed lithology generally make up 2 to 6 percent, by volume, of the solum, but the upper part generally has less than 2 percent.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1, or it is N 2/0. It is loam, silty clay loam, or clay loam. The upper part of the B horizon has a matrix with hue of 10YR through 5Y and value of 3 or 4. Where hue is 10YR, chroma is 1; and where hue is 2.5Y or 5Y, chroma is 1 or 2. The lower part of the B horizon has a matrix with hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. In some pedons distinct or prominent mottles are in some part of the B horizon. The B horizon is loam, silty clay loam, or clay loam. Some pedons have a BC horizon. Reaction in the B horizon ranges from slightly acid to strongly acid, but it is mildly alkaline in the lower part in some pedons. The C horizon has a matrix with 5Y or 2.5Y hue. It is loam or clay loam.

Crystal Lake series

The Crystal Lake series consists of deep, moderately well drained soils on end moraines. They are moderately permeable. These soils formed in silty eolian and lacustrine sediments. Slopes range from 1 to 8 percent.

The Crystal Lake soils in Dakota County do not have tongues of albic material in the upper part of the B horizon and have a higher base saturation than is defined as the range for the series. These differences do not alter the usefulness or behavior of the soils.

The Crystal Lake soils are similar to the Spencer soils and are commonly adjacent to the higher Antigo, Chetek, and Kingsley soils. The Spencer soils are underlain by sandy loam glacial till. The Antigo soils are underlain by sand and gravel and are well drained. The Chetek soils are underlain by sand and are somewhat excessively drained. The Kingsley soils formed mainly in sandy loam till and are well drained.

Typical pedon of Crystal Lake silt loam, 1 to 8 percent slopes, 300 feet west and 660 feet north of the southeast corner of sec. 21, T. 27 N., R. 23 W.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) silt loam, brown (10YR 5/2) dry; weak fine granular structure; very friable; slightly acid; abrupt smooth boundary.

Bt1—9 to 18 inches; dark brown (7.5YR 4/4) silt loam; moderate fine subangular blocky structure; friable; few very thin clay films on faces of peds; medium acid; clear wavy boundary.

Bt2—18 to 26 inches; dark brown (7.5YR 4/4) silty clay loam; moderate medium subangular blocky structure; firm; few very thin clay films on faces of peds; slightly acid; clear wavy boundary.

BtC—26 to 40 inches; dark yellowish brown (10YR 4/4) silty clay loam; few fine faint grayish brown (10YR 5/2) and yellowish brown (10YR 5/8) mottles; moderate medium subangular blocky structure; firm; few very thin clay films on faces of peds; slightly acid; clear wavy boundary.

C1—40 to 55 inches; brown (10YR 4/3) silty clay loam; few medium distinct strong brown (7.5YR 5/6) mottles; weak medium platy structure; firm; brown (10YR 5/3) coatings of clean silt and sand on faces of peds; neutral; clear wavy boundary.

C2—55 to 60 inches; brown (10YR 4/3) silty clay loam; common medium distinct light yellowish brown (10YR 6/4) mottles; moderate medium platy structure; firm; brown (10YR 5/3) coatings of clean silt and sand on faces of peds; neutral.

The thickness of the solum ranges from 24 to 50 inches. The Ap horizon has value of 4 or 5 and chroma of 2 or 3. Pedons in uncultivated areas have a 1- to 4-inch thick A horizon that has value of 2 or 3 and chroma of 1. Some pedons have an E horizon with value of 4 through 6 and chroma of 2 or 3. The Bt horizon has hue of 10YR, 7.5YR, or 5YR; value of 4 or 5; and chroma of 3 or 4. Texture is silt loam or silty clay loam. Reaction is slightly acid to strongly acid. The C horizon has hue of 10YR, 7.5YR, or 5YR; value of 4 to 6; and chroma of 3 or 4. It is dominantly silt loam or silty clay loam but has thin strata of fine or very fine sandy loam, fine or very fine sand, loamy fine sand, loamy very fine sand, or loam.

Cylinder series

The Cylinder series consists of deep, somewhat poorly drained soils on outwash plains and stream benches. They are moderately permeable in the upper part and very rapidly permeable in the lower part. These soils formed in loamy glacial drift and the underlying sandy sediments. Slopes range from 0 to 2 percent.

The Cylinder soils are commonly adjacent to the lower Marshan soils and the higher Kanaranzi and Waukegan soils. The Marshan soils are poorly drained. The Waukegan soils are well drained.

Typical pedon of Cylinder loam, 0 to 2 percent slopes, 520 feet north and 2,580 feet west of the southwest corner of sec. 10, T. 113 N., R. 20 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; friable; slightly acid; abrupt smooth boundary.

AB—8 to 12 inches; very dark grayish brown (10YR 3/2) loam, dark brown (10YR 4/3) dry; moderate fine granular structure; friable; slightly acid; clear wavy boundary.

Bw1—12 to 18 inches; dark brown (10YR 4/3) loam; few fine faint yellowish brown (10YR 5/6) and light brownish gray (10YR 6/2) mottles; moderate medium subangular blocky structure; friable; neutral; clear smooth boundary.

Bw2—18 to 25 inches; dark brown (10YR 4/3) loam; common fine faint yellowish brown (10YR 5/6) and light brownish gray (10YR 6/2) mottles; moderate medium subangular blocky structure; friable; neutral; clear wavy boundary.

2Bw—25 to 28 inches; dark brown (10YR 4/3) loamy sand; common coarse faint yellowish brown (10YR 5/6) and light brownish gray (10YR 6/2) mottles; weak medium subangular blocky structure; very friable; 5 percent coarse fragments; neutral; clear wavy boundary.

2C—28 to 60 inches; dark yellowish brown (10YR 4/4) sand; common coarse faint yellowish brown (10YR 5/6) and light brownish gray (10YR 6/2) mottles; single grain; loose; 5 percent coarse fragments; slightly alkaline.

The thickness of the solum ranges from 24 to 45 inches. The depth to carbonates and to sand and gravel is 24 to 40 inches. The mollic epipedon is 10 to 24 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Texture is loam or clay loam. The B horizon has value of 4 or 5 and chroma of 2 or 3. In some pedons the B horizon has hue of 2.5Y, value of 4 or 5, and chroma of

2. Texture is loam or clay loam. The texture of the 2B horizon ranges from loamy sand to gravelly coarse sand that is 5 to 50 percent coarse fragments. Reaction in the B horizon is slightly acid or neutral. The 2C horizon has value of 3 through 6 and chroma of 2 through 4. Texture is gravelly coarse sand, stratified coarse sand and sand, or loamy sand. Coarse fragments range from 5 to 50 percent.

Dickinson series

The Dickinson series consists of deep, well drained and somewhat excessively drained soils on uplands, outwash plains, and terraces. They are moderately rapidly permeable in the upper part and rapidly permeable in the lower part. These soils formed in loamy glacial drift and sandy alluvial sediments. Slopes range from 0 to 6 percent.

The Dickinson soils are similar to the Etter soils. They are similar in position and commonly adjacent to the Ostrander, Sparta, and Wadena soils. The Etter soils are underlain by sandstone bedrock and are in the uplands. The Ostrander soils formed in silt-mantled glacial till on uplands. The Sparta soils have more fine sand in the solum than the Dickinson soils, and the Wadena soils have more clay in the upper part of the solum.

Typical pedon of Dickinson sandy loam, 0 to 2 percent slopes, 2,360 feet east and 20 feet north of center of sec. 14, T. 114 N., R. 17 W.

Ap—0 to 10 inches; very dark brown (10YR 2/2) sandy loam, very dark grayish brown (10YR 3/2) dry; weak medium granular structure; very friable; strongly acid; abrupt smooth boundary.

A—10 to 13 inches; very dark brown (10YR 2/2) sandy loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; very friable; medium acid; clear wavy boundary.

AB—13 to 16 inches; very dark grayish brown (10YR 3/2) sandy loam, dark brown (10YR 4/3) dry; weak fine subangular blocky structure; very friable; medium acid; clear wavy boundary.

Bw—16 to 25 inches; dark brown (7.5YR 3/4) sandy loam; moderate fine subangular blocky structure; friable; medium acid; clear smooth boundary.

BC—25 to 36 inches; dark brown (7.5YR 4/4) sand; weak moderate subangular blocky structure parting to single grain; very friable; strongly acid; abrupt smooth boundary.

C—36 to 60 inches; dark brown (10YR 4/4) sand; single grain; loose; medium acid.

The thickness of the solum ranges from 24 to 50 inches. Depth to loamy sand and sand is generally 24 to 36 inches but ranges from 20 to 42 inches. Typically, the solum and underlying material are free of very coarse sand and gravel to a depth of more than 60 inches, but soils that have such materials between depths of 40 and 60 inches are not excluded.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Texture is fine sandy loam, sandy loam, or loam. The B horizon has hue of 10YR or 7.5YR, value of 3 through 5, and chroma of 2 through 6. The B horizon is sandy loam or fine sandy loam in the upper part grading to loamy fine sand, loamy sand, fine sand, or sand in the lower part. Reaction ranges from strongly acid to slightly acid. The C horizon has value of 4 or 5 and chroma of 3 through 6. It is loamy fine sand, loamy sand, fine sand, or sand. In some pedons a few high-chroma mottles are in the lower part of the B horizon and in the C horizon.

Emmert series

The Emmert series consists of deep, excessively drained soils on end moraines. They are very rapidly permeable and formed in sandy outwash. Slopes range from 3 to 15 percent.

The Emmert soils are similar to the Salida soils. They are similar in position and commonly adjacent to the Chetek, Kingsley, and Mahtomedi soils. The Salida soils have a thicker, darker surface layer. The Chetek soils have less gravel in the subsoil; the Kingsley soils formed in sandy loam glacial till; and the Mahtomedi soils have fewer coarse fragments.

Typical pedon of Emmert very gravelly sandy loam, 3 to 15 percent slopes, 1,640 feet east and 300 feet south of the center of sec. 24, T. 115 N., R. 20 W.

A—0 to 4 inches; very dark gray (10YR 3/1) very gravelly sandy loam, dark brown (10YR 3/3) dry; weak medium granular structure; very friable; 58 percent coarse fragments; slightly acid; clear wavy boundary.

BA—4 to 7 inches; dark brown (7.5YR 4/4) very gravelly loamy sand; single grain; loose; 72 percent coarse fragments; slightly acid; clear wavy boundary.

Bw—7 to 22 inches; brown (7.5YR 4/4) very gravelly loamy sand; single grain; loose; 67 percent coarse fragments; slightly acid; clear wavy boundary.

C—22 to 60 inches; strong brown (7.5YR 5/6) gravelly sand; single grain; loose; 35 percent coarse fragments; slightly acid.

The thickness of the solum ranges from 12 to 28 inches. Carbonates are below a depth of 4 feet in some pedons. Coarse fragments range from 35 to 75 percent.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Some pedons have an A2 horizon that is less than 4 inches thick. It is coarse sandy loam, sandy loam, fine sandy loam, loamy coarse sand, or loamy sand in the fine earth fraction. The B horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 through 4. It is coarse sand, sand, loamy coarse sand, or loamy sand in the fine earth fraction. Reaction ranges from neutral to strongly acid. The C horizon has value of 3 through 5

and chroma of 3 through 6. It is sand or coarse sand in the fine earth fraction.

Estherville series

The Estherville series consists of deep, somewhat excessively drained soils on outwash plains and stream terraces. Permeability is moderately rapid in the upper part and rapid in the lower part. These soils formed in loamy glacial outwash sediments and the underlying sandy and gravelly deposits. Slopes range from 0 to 6 percent.

The Estherville soils are similar to the Chetek and Kanaranzi soils and are commonly adjacent to the Cylinder, Kanaranzi, and Wadena soils. The Chetek soils have an argillic horizon and are on end moraines. The Kanaranzi and Wadena soils have more clay in the solum than the Estherville soils. The Cylinder soils are lower and somewhat poorly drained.

Typical pedon of Estherville sandy loam, 0 to 2 percent slopes, 660 feet south and 2,550 feet west of the northeast corner of sec. 15, T. 112 N., R. 19 W.

Ap—0 to 9 inches; very dark brown (10YR 2/2) sandy loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; friable; about 5 percent coarse fragments; neutral; abrupt smooth boundary.

AB—9 to 13 inches; very dark grayish brown (10YR 3/2) sandy loam, dark brown (10YR 4/3) dry; weak fine granular structure; friable; about 5 percent coarse fragments; slightly acid; clear wavy boundary.

Bw—13 to 21 inches; dark yellowish brown (10YR 3/4) sandy loam; weak moderate subangular blocky structure; very friable; about 12 percent coarse fragments; neutral; gradual wavy boundary.

2BC—21 to 26 inches; dark yellowish brown (10YR 3/4) gravelly loamy sand; weak moderate subangular blocky structure; loose; about 35 percent coarse fragments; neutral; gradual wavy boundary.

2C—26 to 60 inches; grayish brown (10YR 5/2), yellowish brown (10YR 5/4) and light yellowish brown (10YR 5/6) sand; single grain; loose; slight effervescence; about 10 percent coarse fragments; neutral.

The thickness of the solum and depth to the 2C horizon range from 15 to 30 inches. The mollic epipedon is 9 to 18 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Texture is sandy loam or loam. Coarse fragments range from 5 to 15 percent. The B horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 through 4. Texture is coarse loamy sand, sandy loam, coarse sandy loam, or their gravelly analogs. Coarse fragments range from 5 to 35 percent. Reaction ranges from medium acid through neutral. The C horizon has variegated colors with chroma of 2 through 6. Texture is sand, coarse sand, or gravelly coarse sand. Coarse fragments range from 10 to 50 percent. Thin strata of medium and fine sand are in many pedons.

Etter series

The Etter series consists of moderately deep, well drained soils on uplands. They are permeable in the upper part and moderately rapidly permeable in the lower part. These soils formed in loamy glacial drift underlain by sandy residuum from sandstone. Slopes range from 2 to 12 percent.

The Etter soils are similar to the Dickinson soils and are commonly adjacent to the Boone, Ostrander, and Waukegan soils. The Dickinson soils have no sand residuum from sandstone within 60 inches of the surface. The Boone soils are generally upslope and excessively drained. The Ostrander soils formed in silt-mantled, loamy glacial till on uplands. The Waukegan soils have more silt and clay in the upper part of the solum and are on outwash plains.

Typical pedon of Etter fine sandy loam, 2 to 6 percent slopes, 50 feet north and 50 feet east of the southwest corner of sec. 17, T. 113 N., R. 18 W.

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

A—7 to 15 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark brown (10YR 4/3) dry; weak fine subangular blocky structure; friable; medium acid; clear wavy boundary.

Bw—15 to 21 inches; dark brown (10YR 4/3) fine sandy loam; weak fine subangular blocky structure; friable; medium acid; clear wavy boundary.

2C—21 to 60 inches; brownish yellow (10YR 6/6) and yellow (10YR 7/6) fine sand; single grain; loose; slightly acid.

The thickness of the solum and depth to sandy residuum range from 20 to 40 inches. The mollic epipedon is 10 to 20 inches thick. Coarse fragments range from 0 to 5 percent, by volume, in the upper part of the profile and from 0 to 10 percent in the lower part. Some pedons have a thin horizon with up to 50 percent coarse fragments immediately above the sandstone.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Texture is fine sandy loam, sandy loam, loam, or silt loam. The B horizon has hue of 10YR or 7.5YR, value of 3 through 5, and chroma of 3 or 4. Texture is loam, sandy loam, coarse sandy loam, or fine sandy loam. Reaction ranges from strongly acid through neutral. Some pedons have a 2BC horizon up to 4 inches thick. The 2C horizon has value of 5 through 7 and chroma of 2 through 6.

Faxon series

The Faxon series consists of moderately deep, poorly drained and very poorly drained soils on terraces of flood plains. These soils are moderately permeable. They formed in silty to clayey alluvium underlain by limestone bedrock. Slopes range from 0 to 2 percent.

The Faxon soils in Dakota County have dark surface colors that extend below a depth of 24 inches and a higher clay content in the solum than is defined as the range for the series. These differences do not alter the usefulness or behavior of the soils.

The Faxon soils are similar in position and commonly adjacent to the Oshawa and Seelyeville soils. The Oshawa soils are deep to bedrock. The Seelyeville soils formed in highly decomposed organic material.

Typical pedon of Faxon silty clay loam, 2,210 feet north and 780 feet east of the southwest corner of sec. 32, T. 27 N., R. 24 W.

A1—0 to 12 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; moderate fine granular structure; very friable; strong effervescence; mildly alkaline; clear wavy boundary.

A2—12 to 17 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; weak medium subangular blocky structure; very friable; strong effervescence; 2 percent coarse fragments; moderately alkaline; clear wavy boundary.

A3—17 to 23 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; slight effervescence; 1 percent coarse fragments; moderately alkaline; clear wavy boundary.

A4—23 to 28 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; common medium distinct strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; very friable; strong effervescence; about 10 percent coarse fragments; moderately alkaline; abrupt smooth boundary.

2Cg1—28 to 34 inches; grayish brown (2.5Y 5/2) flaggy loam (weathered bedrock); common medium distinct strong brown (7.5YR 5/6) mottles; massive; very friable; strong effervescence; about 30 percent coarse fragments; moderately alkaline; clear wavy boundary.

2Cg2—34 to 37 inches; light gray (2.5Y 7/1) flaggy silt loam (weathered bedrock); massive; friable; strong effervescence; about 30 percent coarse fragments; moderately alkaline; abrupt smooth boundary.

2R—37 inches; limestone bedrock.

The thickness of the solum and depth to bedrock range from 20 to 40 inches. The mollic epipedon is 10 to 40 inches thick. Coarse fragments of mixed lithology make up 0 to 10 percent, by volume, of the solum. The horizon underlain by bedrock is up to 35 percent coarse fragments.

Some pedons have an O horizon about 6 inches or less in thickness. The A horizon has hue of 10YR, 2.5Y, or 5Y and value of 2 or 3, or it is N 2 or N 3. Texture is loam, silt loam, clay loam, sandy clay loam, silty clay loam, silty clay, or clay. Some pedons have a B horizon similar in texture to the A horizon. The 2C horizon is loam or silt loam, composed primarily of weathered limestone. It has value of 5 through 7 and chroma of 1 or 2.

Frontenac series

The Frontenac series consists of deep, well drained soils on side slopes of dissected terrain. They are moderately permeable in the upper part and moderately rapidly permeable in the lower part. These soils formed in loamy sediments underlain by weathered limestone. Slopes range from 25 to 40 percent.

The Frontenac soils are similar to the Marlean soils and are commonly adjacent to the Brodale, Port Byron, Rockton, and Terril soils. The Marlean soils are deeper to bedrock and more sloping than the Frontenac soils. The Brodale soils are on south- to west-facing side slopes; the Port Byron soils are on summits; the Rockton soils are upslope; and the Terril soils are generally downslope from the Frontenac soils. The Brodale soils have at least 35 percent coarse fragments in the solum; the Port Byron soils formed in loess; the Rockton soils have an argillic horizon; and the Terril soils have a thick, dark mollic epipedon.

Typical pedon of Frontenac loam, 25 to 40 percent slopes, 880 feet east and 560 feet north of the southwest corner of sec. 33, T. 114 N., R. 16 W.

A—0 to 6 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium granular structure; friable; about 2 percent coarse fragments, mostly channers; neutral; clear wavy boundary.

AB—6 to 11 inches; very dark grayish brown (10YR 3/2) loam, dark brown (10YR 4/3) dry; weak fine subangular blocky structure parting to weak fine granular; about 3 percent coarse fragments, mostly channers; neutral; clear wavy boundary.

Bw1—11 to 18 inches; dark brown (10YR 4/3) loam; moderate medium subangular blocky structure; friable; about 12 percent coarse fragments, mostly channers and about 5 percent flagstones; neutral; clear wavy boundary.

Bw2—18 to 24 inches; dark yellowish brown (10YR 4/4) loam; moderate medium subangular blocky structure; friable; about 12 percent coarse fragments, mostly channers, and about 5 percent flagstones; slight effervescence; neutral; clear wavy boundary.

2C1—24 to 38 inches; yellowish brown (10YR 5/4) flaggy loam; moderate coarse subangular blocky structure; friable; about 35 percent coarse fragments, mostly flagstones; strong effervescence; mildly alkaline; gradual wavy boundary.
2C2—38 to 60 inches; yellowish brown (10YR 5/4) very flaggy loam; massive; friable; about 60 percent coarse fragments, mostly flagstones; violent effervescence; mildly alkaline.

The thickness of the solum and depth to the IIC horizon range from 20 to 40 inches. Depth to free carbonates in the fine earth fraction ranges from 18 to 60 inches. Coarse fragments are mostly flagstones or channers of limestone, but cobble-size fragments are within the range.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or silt loam. Volume of coarse fragments ranges from 0 to 10 percent. The B horizon has value of 4 or 5 and chroma of 3 or 4. It is loam or silt loam. Volume of coarse fragments ranges from 2 to 20 percent. Reaction ranges from medium acid to neutral. The 2C horizon has value of 5 through 8 and chroma of 3 through 5. Texture is flaggy, channery, or cobbly sandy loam, loam, or silt loam. Volume of coarse fragments ranges from 35 to 70 percent.

Garwin series

The Garwin series consists of deep, poorly drained soils in swales and upland drainageways. They are moderately permeable. These soils generally formed in 6 to 10 feet of loess. Slopes range from 0 to 2 percent.

The Garwin soils are similar to the Maxcreek and Maxfield soils and are commonly adjacent to the lower Colo soils, the slightly higher Joy soils, and the higher Port Byron soils. The Maxcreek and Maxfield soils are underlain by glacial till and are in concave heads of drainageways. The Colo soils have a thicker, darker mollic epipedon than the Garwin soils. The Joy soils are somewhat poorly drained, and the Port Byron soils are well drained.

Typical pedon of Garwin silty clay loam, 1,000 feet south and 150 feet east of the northwest corner of sec. 26, T. 114 N., R. 20 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.
A—8 to 14 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; neutral; abrupt wavy boundary.
Bwg1—14 to 18 inches; dark grayish brown (2.5Y 4/2) silty clay loam; few fine distinct strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
Bwg2—18 to 28 inches; grayish brown (2.5Y 5/2) silty clay loam; few fine distinct strong brown (7.5YR 5/6 and 7.5YR 5/8) mottles; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
Bwg3—28 to 37 inches; grayish brown (2.5Y 5/2) silty clay loam; common medium distinct strong brown (7.5YR 5/6) and yellowish red (5YR 4/6) mottles; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
BCg—37 to 42 inches; grayish brown (2.5Y 5/2) silt loam; many coarse and medium distinct gray (10YR 5/1) and strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; friable; common soft black accumulations (iron and manganese oxides); neutral; clear smooth boundary.
Cg—42 to 60 inches; grayish brown (2.5Y 5/2) silt loam; common, fine distinct strong brown (10YR 5/8) and yellowish brown (7.5YR 5/6) mottles; massive; friable; neutral.

The thickness of the solum ranges from 40 to 60 inches. In some pedons free carbonates are at a depth of 48 to 72 inches.

The Ap and A1 horizons are 10YR 2/1 or N 2/0 in color. Generally, a few mottles of higher chroma and value are in the AB horizon. Some pedons have a BA horizon with hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 1. The B horizon has hue of 5Y or 2.5Y, value of 3 through 5, and chroma of 1 or 2. It has few to many mottles with 2.5Y through 7.5YR hue, value of 4 through 6, and chroma of 4 through 8. The BCg 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 silt loam. Reaction in the B horizon ranges from medium acid to neutral. The C horizon has matrix colors with hue of 5Y or 2.5Y, value of 4 through 6, and chroma of 1 or 2.

Glencoe series

The Glencoe series consists of deep, very poorly drained soils in depressions and swales on end moraines. They are moderately permeable and moderately slowly permeable. These Glencoe soils formed in silty sediments and in the underlying loamy glacial till. Slopes range from 0 to 1 percent.

The Glencoe soils are similar to the Colo soils and are commonly adjacent to the slightly higher Hamel and Webster soils. The Colo soils formed entirely in silty sediments. The Hamel soils have an argillic horizon, and the poorly drained Webster soils have a thinner mollic epipedon than the Glencoe soils.

Typical pedon of Glencoe silty clay loam, 300 feet west and 600 feet south of the center of sec. 3, T. 112 N., R. 20 W.

A1—0 to 12 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; few fine distinct strong brown (7.5YR 5/6) mottles; weak medium granular structure; friable; slightly acid; clear wavy boundary.
A2—12 to 21 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; few fine distinct strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; friable; slightly acid; clear wavy boundary.
A3—21 to 26 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; few fine yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; neutral; clear wavy boundary.
Bg—26 to 38 inches; grayish brown (2.5Y 5/2) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak medium and coarse subangular blocky structure; friable; mildly alkaline; clear wavy boundary.
Cg—38 to 60 inches; grayish brown (2.5Y 5/2) clay loam; few fine distinct yellowish brown (10YR 5/6) and gray (N 6/0) mottles; massive; 2 percent coarse fragments; friable; mildly alkaline.

The thickness of the solum and depth to free carbonates are 30 to 60 inches. The mollic epipedon ranges from 24 to 46 inches in thickness. Some pedons have an O horizon up to 6 inches in thickness.

The A horizon has hue of 10YR through 5Y, value of 2 or 3, or it is N 2/0 or N 3/0. Some pedons do not have mottles in the A horizon. The A horizon is clay loam, silty clay loam, or loam. Coarse fragments range from 0 to 5 percent. A few free carbonates are in the upper part of the A horizon in some pedons. The B horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. Mottles range from few to many and faint to prominent. Texture is loam, clay loam, or silty clay loam. Coarse fragments range from 0 to 5 percent. Reaction ranges from neutral to mildly alkaline. The C horizon has hue of 5Y or 2.5Y, value of 4 through 6, and chroma of 2 through 4. Some pedons do not have mottles in the C horizon. It is loam or clay loam. Coarse fragments range from 2 to 8 percent.

Gotham series

The Gotham series consists of deep, somewhat excessively drained soils on uplands, stream terraces, and outwash plains. They are moderately rapidly permeable in the upper part and rapidly permeable in the lower part. These soils formed in sandy sediments. Slopes range from 0 to 12 percent.

The Gotham soils in Dakota County do not have an argillic horizon and have a thicker solum than is defined as the range for the series. These differences do not alter the usefulness or behavior of the soil.

The Gotham soils are similar to the Plainfield and Sparta soils and are commonly adjacent to the Sparta and Hubbard soils. The Plainfield soils formed in coarser textured sands. The Sparta and Hubbard soils have a mollic epipedon. All of these similar and adjacent soils lack the argillic horizon characteristic of the Gotham soils.

Typical pedon of Gotham loamy fine sand, 0 to 2 percent slopes, 1,820 feet west and 660 feet south of the northeast corner of sec. 34, T. 27 N., R. 23 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak very fine granular structure; loose; strongly acid; abrupt smooth boundary.
BA—9 to 25 inches; dark brown (10YR 4/3) loamy fine sand; weak very fine granular structure; loose; slightly acid; clear wavy boundary.
Bw—25 to 40 inches; dark yellowish brown (10YR 4/4) fine sand; weak very fine subangular blocky structure; loose; slightly acid; abrupt wavy boundary.
Bt—40 to 48 inches; dark brown (7.5YR 4/4) fine sand; weak medium subangular blocky structure; loose; clay fraction bridges sand grains and occupies some of the pores; slightly acid; clear wavy boundary.
C—48 to 60 inches; dark brown (7.5YR 4/4) fine sand; massive parting to single grain; loose; slightly acid.

The thickness of the solum ranges from 24 to 50 inches.

The A horizon has hue of 10YR or 7.5YR and value and chroma of 2 or 3. The texture is loamy fine sand, loamy sand, or fine sandy loam. Some pedons have a thin, loamy fine sand or loamy sand A2 horizon. The Bw horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 through 6. Texture is loamy sand, fine sand, or loamy fine sand. The Bt horizon has hue of 10YR, 7.5YR, or 5YR; value of 4 or 5; and chroma of 4 through 6. It is loamy fine sand, fine sand, or loamy sand. Reaction is strongly acid to neutral. The C horizon has hue of 10YR, 7.5YR, or 5YR; value of 4 through 6; and chroma of 3 through 6. It is loamy fine sand, loamy sand, fine sand, or sand. Some pedons have lamellae 1/8 to 1 inch thick in the lower part of the C horizon.

Hamel series

The Hamel series consists of deep, poorly drained soils in swales and drainageways on end moraines. They are moderately slowly permeable. These soils formed in silty alluvium or colluvium and the underlying loamy glacial till. Slopes range from 0 to 3 percent.

The Hamel soils are similar to the Cordova soils and are commonly adjacent to the Glencoe, Lester, and Le Sueur soils. The Cordova soils have a mollic epipedon less than 24 inches thick. The Glencoe soils are lower and very poorly drained; the Lester soils are steeper and well drained; and the Le Sueur soils are slightly higher

than the Hamel soils and moderately well drained to somewhat poorly drained.

Typical pedon of Hamel silt loam, 2,360 feet west and 920 feet north of the southeast corner of sec. 3, T. 112 N., R. 20 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; medium acid; abrupt smooth boundary.

A—8 to 16 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; angular blocky structure; friable; neutral; clear wavy boundary.

Btg1—16 to 25 inches; very dark gray (10YR 3/1) silty clay loam, dark brown (10YR 3/3) dry; strong fine subangular blocky structure; friable; few thin clay films on faces of peds; neutral; clear wavy boundary.

Btg2—25 to 31 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark brown (10YR 3/3) dry; few fine faint grayish brown (10YR 5/2) mottles; strong fine subangular blocky structure; friable; continuous thin clay films on faces of peds; neutral; clear wavy boundary.

Btg3—31 to 40 inches; dark grayish brown (2.5Y 4/2) loam; few fine distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; 2 percent coarse fragments; continuous thin clay films on faces of peds; neutral; clear wavy boundary.

C1—40 to 52 inches; olive brown (2.5Y 4/4) loam; common fine distinct grayish brown (10YR 5/2) mottles; massive; friable; 5 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

C2—52 to 60 inches; olive brown (2.5Y 4/4) loam; few fine distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; massive; friable; 5 percent coarse fragments; strong effervescence; mildly alkaline.

The thickness of the solum and depth to free carbonates range from 30 to 65 inches. The mollic epipedon is 24 to 44 inches thick. Typically, the upper 30 inches of the solum does not have coarse fragments, or it contains less than 2 percent coarse fragments. The lower part of the solum contains 2 to 6 percent, by volume, coarse fragments of mixed lithology.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1, or it is N 2/0 or N 3/0. Typically, it is loam or silt loam, but light clay loam or light silty clay loam are within the range. The upper B horizon has hue of 10YR, 2.5Y, or 5Y; value of 2 or 3; and chroma of 1 or 2. The lower B horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. Mottles range from few to many and faint to prominent. Texture is clay loam, silty clay loam, or loam. Reaction ranges from neutral to medium acid. Clay films in the B2 horizon range from thin to thick and few to continuous. The matrix of the C horizon has hue of 2.5Y or 5Y and chroma of 2 through 4.

Hawick series

The Hawick series consists of deep, excessively drained soils on stream terraces and outwash plains. They are rapidly permeable in the upper part and very rapidly permeable in the lower part. These soils formed in loamy alluvium and sandy and gravelly outwash deposits. Slopes range from 6 to 50 percent.

The Hawick soils are similar to the Burkhardt and Estherville soils and are commonly adjacent to the Estherville and Wadena soils. The Estherville soils are similar in position to the Hawick soils but formed in contrasting material and have a finer texture in the solum. The Burkhardt soils do not have carbonates. The Wadena soils have more clay and less sand in the solum than the Hawick soils and are lower on the landscape.

Typical pedon of Hawick coarse sandy loam, 6 to 12 percent slopes, 400 feet west and 625 feet north of the southeast corner of sec. 14, T. 114 N., R. 19 W.

Ap—0 to 8 inches; black (10YR 2/1) coarse sandy loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; friable; about 12 percent coarse fragments; slightly acid; abrupt smooth boundary.

AB—8 to 11 inches; very dark grayish brown (10YR 3/2) gravelly loamy coarse sand, dark brown (10YR 3/3) dry; weak very fine subangular blocky structure; very friable; about 28 percent coarse fragments; slightly acid; gradual wavy boundary.

Bw—11 to 15 inches; dark brown (10YR 3/3) gravelly loamy coarse sand, dark brown (10YR 4/3) dry; weak very fine subangular blocky structure; very friable; about 35 percent coarse fragments; neutral; gradual wavy boundary.

BC—15 to 21 inches; dark yellowish brown (10YR 4/4) gravelly coarse sand; single grain; loose; about 35 percent coarse fragments; neutral; gradual smooth boundary.

C—21 to 60 inches; yellowish brown (10YR 5/4) very gravelly coarse sand; single grain; loose; slight effervescence; about 60 percent coarse fragments; mildly alkaline.

The thickness of the solum and the depth to free carbonates generally are 10 to 26 inches. The mollic epipedon is 7 to 16 inches thick. The solum averages 5 to 35 percent coarse fragments, but some subhorizons contain up to 60 percent coarse fragments.

The A horizon has value of 2 or 3 and chroma of 1 through 3. It is loamy sand, loamy coarse sand, gravelly loamy coarse sand, sandy loam, or coarse sandy loam. The B horizon has hue of 7.5YR or 10YR, value of 3 through 5, and chroma of 3 or 4. It is loamy sand, loamy coarse sand, coarse sand, or their gravelly analogs. Reaction ranges from slightly acid to mildly alkaline. The

C horizon has hue of 10YR or 7.5YR, value of 4 through 6, and chroma of 2 through 6. It generally is stratified with texture of coarse sand or sand and their gravelly analogs.

Hubbard series

The Hubbard series consists of deep, excessively drained soils on outwash plains. They are rapidly permeable. These soils formed in sandy glacial outwash sediments. Slopes range from 0 to 18 percent.

The Hubbard soils are similar to the Plainfield and Sparta soils and are commonly adjacent to the Plainfield, Sparta, and Zumbro soils. The Plainfield and Sparta soils are similar in landscape position to the Hubbard soils. The Plainfield soils do not have a mollic epipedon. The Sparta soils have more fine and very fine sand in the solum. The Zumbro soils are in lower positions and have a thicker mollic epipedon than the Hubbard soils.

Typical pedon of Hubbard loamy sand, 1 to 6 percent slopes, 50 feet east and 20 feet north of the southwest corner of sec. 9, T. 114 N., R. 16 W.

A1—0 to 9 inches; very dark brown (10YR 2/2) loamy sand; very dark grayish brown (10YR 3/2) dry; weak fine granular structure; very friable; strongly acid; gradual wavy boundary.
A2—9 to 16 inches; very dark grayish brown (10YR 3/2) loamy sand, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; strongly acid; gradual wavy boundary.
BA—16 to 20 inches; dark brown (10YR 3/3) loamy sand, dark brown (10YR 4/3) dry; massive; very friable; medium acid; gradual wavy boundary.
Bw—20 to 38 inches; dark brown (7.5YR 4/4) sand; massive; very friable; medium acid; clear wavy boundary.
C—38 to 60 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; 5 percent coarse fragments; slightly acid.

The thickness of the solum ranges from 25 to 50 inches. The depth to free carbonates is 50 to 100 inches. The mollic epipedon ranges from 10 to 22 inches in thickness. Generally, the solum and C horizon above a depth of 50 inches do not have coarse fragments, but in some pedons coarse fragments make up about 20 percent, by volume.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It generally is coarse sand, sand, loamy coarse sand, or loamy sand. In some pedons it is coarse sandy loam or sandy loam in the upper 10 inches or less. The B horizon has hue of 10YR or 7.5YR, value of 3 through 5, and chroma of 2 through 4. It is coarse sand, sand, loamy coarse sand, or loamy sand. It is strongly acid through neutral. The C horizon has hue of 10YR or 7.5YR, value of 4 through 6, and chroma of 2 through 5. It is coarse sand or sand.

Jewett series

The Jewett series consists of deep, well drained soils on end moraines. They are moderately permeable. These soils formed in loess and the underlying loamy glacial till. Slopes range from 1 to 6 percent.

The Jewett soils in Dakota County do not have tongues of albic material in the upper part of the B horizon and have a higher base saturation than is defined as the range for the series. These differences do not alter the usefulness or behavior of the soils.

The Jewett soils are similar to the Otterholt soils and are commonly adjacent to the Antigo, Chetek, and Kingsley soils. The Antigo and Chetek soils formed in silty or loamy mantles underlain by sandy outwash material. The Kingsley soils have a sandy loam surface layer and subsoil. The Otterholt soils formed in more than 30 inches of silt loam underlain by glacial till. The Jewett and adjacent soils occupy similar positions on the landscape.

Typical pedon of Jewett silt loam, 1 to 6 percent slopes, 2,240 feet south and 50 feet east of the northwest corner of sec. 14, T. 27 N., R. 23 W.

A—0 to 4 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; friable; medium acid; abrupt smooth boundary.
E—4 to 13 inches; brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; friable; medium acid; clear smooth boundary.
Bt1—13 to 24 inches; yellowish brown (10YR 5/4) silt loam; moderate fine and medium subangular blocky structure; friable; thin continuous clay films on faces of peds; medium acid; clear smooth boundary.
2Bt2—24 to 33 inches; dark brown (7.5YR 4/4) loam; moderate fine and medium angular blocky structure; firm; about 10 percent coarse fragments; thin continuous clay films on faces of peds; medium acid; gradual smooth boundary.
2C1—33 to 48 inches; reddish brown (5YR 4/4) sandy loam; moderate medium angular blocky structure; friable; about 20 percent coarse fragments; slightly acid; clear smooth boundary.
2C2—48 to 60 inches; reddish brown (5YR 5/4) sandy loam; massive; friable; about 9 percent coarse fragments; slightly acid.

The solum ranges from 20 to 40 inches in thickness and extends into the underlying glacial till. The thickness of the silty mantle ranges from 15 to 30 inches. Coarse fragments of mixed lithology make up 8 to 20 percent, by volume, of the 2B and 2C horizons.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Where there is an Ap horizon, it has value of 3 through 5 and chroma of 1 through 3. The E horizon has value of 4 through 6 and chroma of 2 or 3. It is silt loam

or silt. The Bt horizon has hue of 10YR or 7.5YR and value and chroma of 4 or 5. The 2Bt horizon has hue of 5YR or 7.5YR and value and chroma of 3 through 5. Texture is loam or sandy loam. Reaction ranges from slightly acid to very strongly acid. The 2C horizon has hue of 5YR or 7.5YR and value and chroma of 3 through 5.

Joy series

The Joy series consists of deep, somewhat poorly drained soils on loess-covered uplands. They are moderately permeable. These soils formed in deep loess. Slopes range from 1 to 5 percent.

The Joy soils are similar to the Klinger soils and are commonly adjacent to the Garwin, Port Byron, and Tallula soils. The Garwin soils are poorly drained and are in broad swales and concave heads of upland drainageways, and the Port Byron and Tallula soils are well drained and are generally upslope from the Joy soils. The Klinger soils formed in loess and underlying glacial till on broad upland glacial till plains.

Typical pedon of Joy silt loam, 1 to 5 percent slopes, 395 feet west and 1,190 feet north of center of sec. 25, T. 114 N., R. 20 W.

Ap—0 to 9 inches; black (10YR 2/1) silt loam, (10YR 4/1) dry; moderate medium granular structure; friable; neutral; abrupt smooth boundary.

A—9 to 14 inches; black (10YR 2/1) silt loam, (10YR 4/1) dry; moderate medium granular structure; friable; neutral; gradual smooth boundary.

AB—14 to 23 inches; dark brown (10YR 3/3) silt loam, (10YR 4/2) dry; moderate medium granular structure; friable; gray uncoated silt grains on faces of peds; neutral; clear smooth boundary.

Bw1—23 to 33 inches; dark grayish brown (2.5Y 4/2) silt loam; common fine distinct dark brown (7.5YR 4/4) and strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

Bw2—33 to 45 inches; olive brown (2.5Y 4/4) silt loam; common fine and medium distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; friable; neutral; gradual smooth boundary.

BC—45 to 55 inches; light olive brown (2.5Y 5/4) silt loam; common fine and medium distinct strong brown (7.5YR 5/6) mottles; weak coarse subangular blocky structure; friable; neutral; gradual wavy boundary.

C—55 to 60 inches; olive brown (2.5Y 4/4) silt loam; common medium distinct strong brown (7.5YR 5/6) and yellowish brown (10YR 5/6) mottles; massive; friable; mildly alkaline.

The thickness of the solum ranges from 36 to 60 inches. The thickness of the mollic epipedon ranges from 10 to 24 inches.

The Ap horizon has value of 2 or 3 and chroma of 1 through 3. The AB horizon has value and chroma of 2 or 3. Some pedons have a BA horizon. The Bw horizon has hue of 7.5YR, 10YR, or 2.5Y; value of 4 through 6; and chroma of 2 through 6. The Bw horizon is mottled with a variety of colors. Mottles with chroma of less than 2 are within a depth of 16 inches in some pedons. The C horizon has value of 4 through 6 and chroma of 1 through 4.

Kalmarville series

The Kalmarville series consists of deep, poorly drained and very poorly drained soils on flood plains. They are moderately rapidly permeable in the upper part and rapidly permeable in the lower part. These soils formed in recent loamy alluvium underlain by sandy alluvium. Slopes are less than 1 percent.

The Kalmarville soils are similar to the Algansee soils and are commonly adjacent to the slightly higher Colo and Zumbro soils. The Colo soils have more clay in the solum, and the Zumbro soils have more sand in the solum than the Kalmarville soils. The Algansee soils have a thinner surface horizon.

Typical pedon of Kalmarville sandy loam, 0 to 1 percent slopes, frequently flooded, 1,300 feet south and 400 feet east of the northwest corner of sec. 8, T. 112 N., R. 19 W.

A—0 to 42 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; few fine distinct yellowish brown (10YR 5/8) mottles; weak thick platy structure parting to weak fine granular; very friable; thin strata of dark grayish brown (10YR 4/2) and very dark grayish brown (10YR 3/2) loam and loamy fine sand; slight effervescence; mildly alkaline; abrupt smooth boundary.

2C—42 to 60 inches; dark grayish brown (10YR 4/2) sand; single grain; loose; strata of gray (10YR 5/1) and grayish brown (10YR 5/2) loamy sand and coarse sand; slight effervescence; mildly alkaline.

The thickness of the loamy A horizon and depth to the 2C horizon ranges from 40 to 60 inches. Some pedons do not have free carbonates.

The A horizon has value of 2 through 4. It is mostly sandy loam but has layers of fine sandy loam, loam, silt loam, loamy fine sand, sand, and coarse sand. Coarse fragments range from 0 to 5 percent. It is neutral or mildly alkaline. The 2C horizon has hue of 10YR or 2.5Y, value of 3 through 5, and chroma of 1 or 2. It is coarse sand, sand, fine sand, loamy coarse sand, loamy sand, or loamy fine sand. Coarse fragments range from 0 to 10 percent.

Kanaranzi series

The Kanaranzi series consists of deep, well drained and somewhat excessively drained soils on outwash plains and valley trains. They are moderately permeable in the upper part and rapidly permeable in the lower part. These soils formed in silty and loamy glacial outwash sediments and the underlying calcareous, sandy deposits. Slopes range from 0 to 12 percent.

The Kanaranzi soils are similar to the Wadena soils and are commonly adjacent to the Cylinder, Estherville, and Waukegan soils. The Wadena soils have a ticker solum than the Kanaranzi soils. The Cylinder soils are downslope and somewhat poorly drained. The Estherville soils have more sand in the solum, and the Waukegan soils have more silt. The Wadena, Estherville, Waukegan, and Kanaranzi soils are in similar positions on the landscape.

Typical pedon of Kanaranzi loam, 0 to 2 percent slopes, 800 feet west and 200 feet south of the northeast corner of sec. 18, T. 113 N., R. 20 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; slightly acid; abrupt smooth boundary.
Bw—9 to 19 inches; dark yellowish brown (10YR 4/4) silt loam; moderate medium subangular blocky structure; friable; slightly acid; clear smooth boundary.
2BC—19 to 23 inches; dark yellowish brown (10YR 4/4) loamy sand; single grain; very friable; neutral; clear smooth boundary.
2C—23 to 60 inches; brown (10YR 5/3) coarse sand; single grain; loose; slight effervescence; mildly alkaline.

The thickness of the solum and depth of free carbonates range from 16 to 28 inches. Depth to the coarse textured 2B or 2C horizon ranges from 14 to 24 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or silt loam. The B horizon has value and chroma of 3 or 4. It is loam or silt loam. It is slightly acid or neutral. Some pedons do not have a 2BC horizon. The 2C horizon has value of 4 through 6 and chroma of 1 through 4. It is coarse sand or gravelly coarse sand.

Kato series

The Kato series consists of deep, poorly drained soils on outwash plains. They are moderately permeable in the upper part and rapidly permeable in the lower part. These soils formed in a silty mantle and the underlying sandy sediments. Slopes range from 0 to 2 percent.

The Kato soils are similar to the Marshan and Mayer soils and are commonly adjacent to the slightly higher Cylinder soils and the higher Waukegan soils. The Marshan soils have more sand in the solum than the Kato soils. The Mayer soils are calcareous throughout the profile. The Cylinder soils are somewhat poorly drained, and the Waukegan soils are well drained.

Typical pedon of Kato silty clay loam is 660 feet east and 2,550 feet north of the southwest corner of sec. 27, T. 114 N., R. 19 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, black (10YR 2/1) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.
A—8 to 12 inches; black (10YR 2/1) silty clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; neutral; abrupt wavy boundary.
ABg—12 to 23 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; few fine distinct strong brown (7.5YR 5/6) mottles; weak coarse subangular blocky structure; friable; neutral; abrupt wavy boundary.
Bg1—23 to 28 inches; olive gray (5Y 5/2) silt loam; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; neutral; clear wavy boundary.
Bg2—28 to 30 inches; olive gray (5Y 5/2) silt loam; weak medium subangular blocky structure; friable; neutral; clear wavy boundary.
2BCg—30 to 33 inches; olive gray (5Y 4/2) loamy sand; weak medium subangular blocky structure; friable; 4 percent coarse fragments; neutral; clear smooth boundary.
2Cg—33 to 60 inches; very dark grayish brown (2.5Y 4/2) sand; single grain; loose; very slight effervescence; 5 percent coarse fragments; neutral.

The thickness of the solum and depth to contrasting materials generally are 20 to 40 inches. Depth to free carbonates ranges from 48 to 60 inches. The mollic epipedon is 14 to 24 inches thick.

The A horizon has hue of 10YR or 2.5Y and value of 2 or 3, or it is N 2/0. It is silt 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 silt loam or silty clay loam. The 2BC horizon is loamy sand, sandy loam, loam, or clay loam. Reaction ranges from medium acid to neutral. The 2C horizon has hue of 10YR through 5Y, value of 4 or 5, and chroma of 2 or 3. It is sand, gravelly sand, coarse sand, or gravelly coarse sand and is 0 to 20 percent coarse fragments.

Kennebec series

The Kennebec series consists of deep, moderately well drained soils in depressions and drainageways on outwash plains. They are moderately permeable. These soils formed in silty alluvium. Slopes range from 0 to 3 percent.

The Kennebec soils are similar to the Lindstrom and Spillville soils and are commonly adjacent to the steeper

Kanaranzi and the slightly higher Waukegan soils. The Spillville soils have a higher sand content throughout the solum than the Kennebec soils. The Kanaranzi soils are underlain by sand and gravel at a depth of 14 to 24 inches. The Waukegan soils are underlain by sand and gravel at a depth of 20 to 40 inches. The Lindstrom soils do not flood and are located in the upper reaches of drainageways.

Typical pedon of Kennebec silt loam, 430 feet east and 440 feet south of the northwest corner of sec. 5, T. 114 N., R. 19 W.

Ap—0 to 12 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; very friable; slightly acid; clear smooth boundary.
A1—12 to 30 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate fine medium subangular blocky structure; friable; slightly acid; diffuse smooth boundary.
A2—30 to 41 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; slightly acid; diffuse smooth boundary.
C—41 to 60 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; few fine faint dark brown (10YR 4/3) mottles; weak medium subangular blocky structure; friable; slightly acid.

The thickness of the solum and of the mollic epipedon ranges from 36 to more than 60 inches. These soils have less than 10 percent fine or coarser sand above a depth of 40 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Overwash with value of 3 or 4 and chroma of 2 is in some pedons. Color value gradually increases 1 or 2 units with depth below the A1 horizon, but chroma remains 1 or 2 to a depth of 60 inches or more. Reaction ranges from medium acid to neutral. In some pedons the increase in value begins in the lower part of the A1 horizon below a depth of 20 inches. Hue is commonly 10YR in the C horizon, but some pedons have hue of 2.5Y. The C horizon has few fine faint to distinct mottles of high chroma.

Kennebec Variant

The Kennebec Variant consists of deep, moderately well drained soils in closed depressions on end moraines. They are moderately permeable. These soils formed in silty colluvium. Slopes range from 0 to 4 percent.

The Kennebec Variant soils are similar to the Kennebec and Lindstrom soils and are commonly adjacent to the well drained Kingsley soils and the excessively drained Mahtomedi soils on uplands. The moderately well drained Kennebec soils and the well drained Lindstrom soils are in drainageways and do not have a buried A horizon.

Typical pedon of Kennebec Variant silt loam, 420 feet west and 400 feet north of the southeast corner of sec. 2, T. 27 N., R. 23 W.

A1—0 to 10 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; moderate fine granular structure; very friable; strongly acid; clear wavy boundary.
A2—10 to 24 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; moderate medium platy structure parting to moderate fine platy; very friable; strongly acid; abrupt smooth boundary.
A3—24 to 37 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate medium platy structure parting to moderate thin platy; very friable; strongly acid; abrupt smooth boundary.
Ab—37 to 52 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; massive; very friable; strongly acid; clear wavy boundary.
Bb—52 to 60 inches; very dark gray (10YR 3/1) silt loam, dark brown (10YR 3/1) dry; weak fine prismatic structure; very friable; strongly acid.

The thickness of the solum ranges from 50 to 60 inches or more. Reaction ranges from strongly acid to mildly alkaline.

The A horizon has value of 3 or 2 and chroma of 1 or 2. It is silt loam, loam, or silty clay loam. Some pedons do not have buried horizons. The B horizon has value of 2 or 3 and chroma of 1 or 2. It is silt loam or silty clay loam.

Kingsley series

The Kingsley series consists of deep, well drained soils on end moraines. They are moderately permeable in the upper part and moderately slowly permeable in the lower part. These soils formed in loamy and sandy glacial till. Slopes range from 3 to 40 percent.

The Kingsley soils are similar to the Carmi soils and are commonly adjacent to the Chetek, Mahtomedi, Otterholt, and Jewett soils. The Carmi soils have a mollic epipedon. The Chetek and Mahtomedi soils have more sand in the solum, and the Otterholt and Jewett soils have a silt loam surface layer. The Kingsley and adjacent soils are in similar positions on the landscape.

Typical pedon of Kingsley sandy loam, 8 to 15 percent slopes, 1,050 feet north and 2,540 feet east of the southwest corner of sec. 29, T. 115 N., R. 20 W.

A—0 to 8 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; 10 percent coarse fragments, slightly acid; abrupt smooth boundary.

E—8 to 12 inches; brown (10YR 4/3) loamy sand, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; very friable; 10 percent coarse fragments; medium acid; clear wavy boundary.
Bt1—12 to 22 inches; dark brown (7.5YR 4/4) gravelly sandy loam; weak fine subangular blocky structure; friable; few thin clay films on faces of peds; 15 percent coarse fragments; medium acid; clear wavy boundary.
Bt2—22 to 27 inches; reddish brown (5YR 4/4) gravelly sandy loam; weak fine subangular blocky structure; friable; few thin clay films on faces of peds; 15 percent coarse fragments; medium acid; clear wavy boundary.
Bw—27 to 38 inches; dark brown (7.5YR 4/4) gravelly sandy loam; weak fine subangular blocky structure; friable; 20 percent coarse fragments; medium acid; clear wavy boundary.
C1—38 to 48 inches; dark brown (7.5YR 4/4) loamy sand; massive; friable; 5 percent coarse fragments; medium acid; diffuse wavy boundary.
C2—48 to 60 inches; dark brown (7.5YR 4/4) sandy loam; massive; friable; 10 percent coarse fragments; neutral.

The thickness of the solum ranges from 30 to 45 inches, and depth to free carbonates ranges from 30 to 100 inches or more. The solum and C horizon are 5 to 20 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, coarse sandy loam, loamy sand, or loamy coarse sand. The E horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 or 3. It is similar in texture to the A horizon, but the coarser textures are common. Some pedons have no E horizon. The B horizon generally has hue of 7.5YR or 5YR, value of 3 or 4, and chroma of 3 or 4. The dominant texture is sandy loam or coarse sandy loam or their gravelly analogs, but sandy clay loam, loamy sand, or loamy coarse sand subhorizons are in some pedons. The reaction of the B horizon is generally strongly acid or medium acid but ranges to mildly alkaline in the lower part. The C horizon generally has hue of 7.5YR, but 5YR is within the range. It has value and chroma of 3 or 4. It is loamy sand, sandy loam, or coarse sandy loam, but thin finer or coarser textured strata are common.

Klinger series

The Klinger series consists of deep, somewhat poorly drained soils on loess-covered till plains. They are moderately permeable. These soils formed in a silty mantle and the underlying firm, loamy glacial till. Slopes range from 1 to 5 percent.

The Klinger soils are similar to the Le Sueur and Merton soils and are commonly adjacent to the lower Maxfield soils and the higher Ostrander soils. The Maxfield soils are poorly drained, and the Ostrander soils are well drained. The Le Sueur soils formed in glacial till and do not have a silty mantle. The Merton soils formed in a silty mantle over friable glacial till.

Typical pedon of Klinger silt loam, 1 to 5 percent slopes, 950 feet west and 600 feet north of the southeast corner of sec. 14, T. 112 N., R. 19 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; slightly acid; abrupt smooth boundary.
A—8 to 13 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; slightly acid; clear wavy boundary.
Bt1—13 to 24 inches; dark grayish brown (10YR 4/2) silt loam; moderate fine subangular blocky structure; friable; very few thin dark brown (10YR 3/3) clay films on faces of peds; slightly acid; clear wavy boundary.
Bt2—24 to 28 inches; dark brown (10YR 4/3) loam high in silt; moderate fine subangular blocky structure; friable; very few thin dark brown (10YR 3/3) clay films on faces of peds; slightly acid; abrupt wavy boundary.
2Bt3—28 to 48 inches; yellowish brown (10YR 5/4) loam; few fine distinct grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; firm; very few thin clay films on faces of peds; 3 percent coarse fragments; slightly acid; clear wavy boundary.
2Bw—48 to 55 inches; grayish brown (2.5Y 5/2) loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; 5 percent coarse fragments; slightly acid; clear wavy boundary.
2C—55 to 60 inches; grayish brown (2.5Y 5/2) loam; few fine distinct yellowish brown (10YR 5/6) mottles; massive; firm; 5 percent coarse fragments; strong effervescence; mildly alkaline.

The solum is generally about 48 inches thick but ranges from 40 to 60 inches. The loess is generally 22 to 40 inches thick. Depth to carbonates ranges from 45 to 65 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The thickness of the A horizon is 13 to 24 inches. Texture is silt loam or silty clay loam. The Bt horizon that formed in loess has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 through 4. Some pedons have thin layers of sandy loam, silt loam, sandy clay loam, or loamy sand between the loess and glacial till. The mottled 2Bt horizon has hue of 2.5Y, value of 5 or 6, and chroma of 2, or hue of 10YR , value of 5, and chroma of 4 through 6. It is generally loam, but in some pedons it is clay loam. Reaction in the B horizon ranges from slightly acid to neutral. The 2C horizon is similar in texture and

color to the lower part of the 2B horizon, but it mainly has high-chroma colors in most pedons. Seams of sand are common in some pedons throughout the underlying glacial till.

Lawson series

The Lawson series consists of deep, somewhat poorly drained soils near major streams. They are moderately permeable. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

The Lawson soils are similar to the Colo and Kennebec soils and are commonly adjacent to the Colo soils and Minneiska soils. The Colo soils are lower on the landscape than the Lawson soils and are poorly drained. The Minneiska soils formed in stratified loamy sediments and are on natural levees. The Kennebec soils are moderately well drained and are on uplands.

Typical pedon of Lawson silt loam, 300 feet west and 2,440 feet south of the northeast corner of sec. 21, T. 114 N., R. 16 W.

A1—0 to 8 inches; very dark brown (10YR 2/2) silt loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; neutral; clear smooth boundary.

A2—8 to 15 inches; dark brown (10YR 3/3) silt loam, dark grayish brown (10YR 4/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; neutral; clear smooth boundary.

AC—15 to 30 inches; dark brown (10YR 3/3) silt loam, grayish brown (10YR 5/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; slight effervescence; mildly alkaline; clear wavy boundary.

Cg—30 to 60 inches; dark grayish brown (10YR 4/2) silt loam; few fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; slight effervescence; mildly alkaline.

The thickness of the solum and of the mollic epipedon ranges from 24 to 36 inches. Depth to free carbonates is generally the same as the thickness of the solum but can be as shallow as 15 inches. Reaction in the solum ranges from slightly acid to mildly alkaline.

The A horizon has value of 2 or 3 and chroma of 1 through 3. It is silt loam or silty clay loam. The C horizon has hue of 10YR or 2.5Y, value of 3 through 6, and chroma of 1 through 3.

Le Sueur series

The Le Sueur series consists of deep, moderately well drained and somewhat poorly drained soils on end moraines. They are moderately permeable. These soils formed in silty and loamy, friable glacial till. Slopes range from 0 to 3 percent.

The Le Sueur soils are similar to the Klinger and Merton soils and are commonly adjacent to the lower Cordova, Hamel, and Webster soils and to the higher Lester soils. The Cordova, Webster, and Hamel soils are poorly drained, and the Lester soils are well drained and are steeper than the Le Sueur soils. The Klinger soils formed in firm glacial till. The Merton soils have a loess mantle underlain by glacial till.

Typical pedon of Le Sueur loam, 1,400 feet south and 290 feet east of the center of sec. 3, T. 112 N., R. 20 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) loam high in silt, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; slightly acid; abrupt smooth boundary.

A—8 to 10 inches; very dark brown (10YR 2/2) loam high in silt, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; slightly acid; clear wavy boundary.

Bt1—10 to 25 inches; dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; few fine faint dark grayish brown (10YR 4/2) mottles; moderate fine subangular blocky structure; friable; few thin clay films; 2 percent coarse fragments; slightly acid; clear wavy boundary.

Bt2—25 to 38 inches; dark brown (10YR 4/3) loam; few fine faint dark grayish brown (10YR 4/2) mottles; weak moderate subangular blocky structure; friable; clay bridging between mineral grains; 2 percent coarse fragments; medium acid; clear wavy boundary.

BC—38 to 53 inches; olive brown (2.5Y 4/4) clay loam; few fine faint grayish brown (2.5Y 5/2) and few fine distinct brownish yellow (10YR 6/6) mottles; weak moderate subangular blocky structure; friable; 5 percent coarse fragments; slightly acid; clear wavy boundary.

C—53 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium faint grayish brown (2.5Y 5/2) mottles; massive; friable; 7 percent coarse fragments; slight effervescence; moderately alkaline.

The thickness of the solum and depth to free carbonates range from 28 to 55 inches. The mollic epipedon is 10 to 18 inches thick. The lower part of the solum and the C horizon contain 2 to 8 percent, by volume, coarse fragments of mixed lithology.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It generally is clay loam or loam and less commonly silt loam high in sand content. Some pedons have an E horizon as much as 3 inches thick. The upper part of the B horizon has hue of 10YR or 2.5Y, value of 3 through 8, and chroma of 2 or 3. It has no mottles in some pedons. The lower part of the B horizon generally has value of 4 or 5 and chroma of 2 through 4. It generally has few or common, faint through prominent mottles. The B horizon ranges from strongly acid to neutral. The C horizon has

hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 2 through 4.

Lester series

The Lester series consists of deep, well drained soils on end moraines. They are moderately permeable These soils formed in friable loam glacial till. Slopes range from 2 to 18 percent.

The Lester soils are similar to the Ostrander and Blooming soils. They are commonly adjacent to the Blooming soils, which are in similar positions, and to the lower Hamel and Le Sueur soils. The Ostrander soils formed in firm glacial till. The Blooming soils have a silty mantle at least 14 inches thick underlain by friable, loamy glacial till. The Hamel soils are poorly drained and are on foot slopes. The Le Sueur soils are moderately well drained to somewhat poorly drained.

Typical pedon of Lester loam, 2 to 6 percent slopes, 2,330 feet west and 400 feet north of the southeast corner of sec. 3, T. 112 N., R. 20 W.

Ap—0 to 6 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; slightly acid; abrupt smooth boundary.
BA—6 to 11 inches; dark brown (10YR 4/3) loam; weak fine subangular blocky structure; friable; slightly acid; clear wavy boundary.
Bt—11 to 23 inches; dark brown (10YR 4/3) clay loam; moderate medium subangular blocky structure; friable; 2 percent coarse fragments; few thin clay films on faces of peds; medium acid; clear wavy boundary.
Bw—23 to 38 inches; brown (10YR 5/3) loam; moderate medium subangular blocky structure; friable; 2 percent coarse fragments; slightly acid; clear wavy boundary.
C1—38 to 50 inches; light yellowish brown (2.5Y 6/4) loam; massive; friable; 3 percent coarse fragments; slight effervescence; moderately alkaline; clear wavy boundary.
C2—50 to 60 inches; light olive brown (2.5Y 5/4) loam; massive; friable; 3 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum and depth to free carbonates range from 20 to 54 inches. Coarse fragments of mixed lithology make up 2 to 8 percent of the volume of the control section.

The A1 or Ap horizon has value of 2 or 3 and chroma of 1 or 2. Where there is an A2 horizon, it has value of 3 or 4 and chroma of 1 or 2. The A horizon generally is loam, but clay loam, sandy loam, or silt loam are in the range. The upper part of the B horizon has chroma of 3 or 4. The lower part of the B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 or 4. The B horizon is clay loam or loam. Reaction ranges from slightly acid to strongly acid, but the lower part of the B horizon in some pedons is neutral. The C horizon has value of 4 through 6 and chroma of 3 through 6. It has grayish segregations of carbonates and reddish or brownish mottles in many pedons.

Lindstrom series

The Lindstrom series consists of deep, well drained soils on loess-covered uplands. They are moderately permeable. These soils formed in silty eolian or alluvial sediments. Slopes range from 1 to 4 percent.

The Lindstom soils are similar to the Kennebec and Terril soils and are commonly adjacent to the Port Byron and Waukegan soils upslope. The Port Byron soils have a thinner mollic epipedon, and the Waukegan soils have a thinner solum and are on outwash plains. The Kennebec soils flood occasionally and are in lower positions in upland draws and on outwash plains. The Terril soils have more sand in the solum and are at the base of steep side slopes.

Typical pedon of Lindstrom silt loam, 1 to 4 percent slopes, 190 feet east and 90 feet south of center of sec. 13, T. 114 N., R. 19 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; slightly acid; abrupt smooth boundary.
A—8 to 26 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable; slightly acid; clear wavy boundary.
AB—26 to 34 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; friable; slightly acid; gradual wavy boundary.
Bw1—34 to 40 inches; dark brown (10YR 3/3) silt loam, dark brown (10YR 4/3) dry; moderate medium subangular blocky structure; friable; few black (10YR 2/1) coatings on ped faces and root channels; slightly acid; gradual wavy boundary.
Bw2—40 to 48 inches; dark brown (10YR 4/3) silt loam; moderate medium subangular blocky structure; friable; slightly acid; clear wavy boundary.
Bw3—48 to 60 inches; dark yellowish brown (10YR 4/4) silt loam; moderate medium subangular blocky structure; friable; slightly acid.

The thickness of the solum and the depth to free carbonates range from 50 to 70 inches. The mollic epipedon is 24 to 54 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is silt loam or loam. The B horizon has value of 3 through 5 and chroma of 3 or 4. Reaction ranges from medium acid to neutral. Some pedons have a BC horizon. In some pedons the C horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. It is silt loam, loam, or very fine sandy loam.

Mahtomedi series

The Mahtomedi series consists of deep, excessively drained soils on pitted outwash plains and end moraines. They are rapidly permeable. These soils formed in sandy and gravelly outwash. Slopes range from 3 to 25 percent.

The Mahtomedi soils are similar to the Chetek, Emmert, Hawick, and Hubbard soils and are commonly adjacent to the Chetek and Kingsley soils. The Chetek soils have more clay in the surface and subsoil horizons, and the Emmert soils have more gravel than the Mahtomedi soils. The Hawick and Hubbard soils have a mollic epipedon. The Kingsley soils formed in sandy loam glacial till. The Mahtomedi, Chetek, and Kingsley soils are in similar positions on the landscape.

Typical pedon of Mahtomedi loamy sand, 8 to 15 percent slopes, 380 feet west and 600 feet south of the center of sec. 29, T. 27 N., R. 22 W.

A—0 to 5 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; 12 percent coarse fragments; slightly acid; abrupt boundary.
Bw1—5 to 27 inches; dark brown (7.5YR 4/4) gravelly coarse sand; single grain; loose; 15 percent coarse fragments; slightly acid; clear wavy boundary.
Bw2—27 to 35 inches; dark yellowish brown (10YR 4/4) coarse sand; single grain; loose; 10 percent coarse fragments; slightly acid; abrupt smooth boundary.
C1—35 to 50 inches; yellowish brown (10YR 5/4) sand; single grain; loose; less than 3 percent coarse fragments; neutral; abrupt smooth boundary.
C2—50 to 60 inches; yellowish brown (10YR 5/4) gravelly coarse sand; single grain; loose; 25 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum is 20 to 40 inches. Coarse fragments in the control section average 10 to 35 percent, by volume.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Texture generally is coarse sand, sand, loamy coarse sand, or loamy sand; but fine sand, loamy fine sand, coarse sandy loam, sandy loam, and fine sandy loam are within the range. Reaction ranges from slightly acid to strongly acid. Some pedons have an E horizon that has hue of 10YR, value of 4 or 5, and chroma of 1 or 2. An Ap horizon in cultivated pedons has hue of 10YR and value and chroma of 3 or 4. The B horizon has hue of 5YR, 7.5YR, or 10YR; value of 4 or 5; and chroma of 4 through 6. Texture is coarse sand, sand, gravelly coarse sand, or gravelly sand. Reaction ranges from slightly acid to strongly acid. The C horizon has hue of 5YR, 7.5YR, or 10YR; value of 5 or 6; and chroma of 3 or 4. Texture is coarse sand, sand, gravelly coarse sand, or gravelly sand.

Marlean series

The Marlean series consists of deep, well drained soils on dissected uplands. They are moderately permeable in the upper part and rapidly permeable in the lower part. These soils formed in loamy sediments underlain by highly fragmented limestone bedrock. Slopes range from 12 to 25 percent.

The Marlean soils are similar to the Brodale soils and are commonly adjacent to the Brodale, Copaston, and Rockton soils. They are also adjacent to the more sloping Frontenac soils. The Brodale soils have a flaggy loam surface layer and subsoil. The Copaston and Rockton soils have solid limestone bedrock at a depth of 40 inches, and the Frontenac soils have thicker loamy sediments underlain by bedrock than the Marlean soils.

Typical pedon of Marlean loam, 12 to 18 percent slopes, 790 feet west and 1,320 feet south of the northeast corner of sec. 32, T. 114 N., R. 16 W.

A—0 to 5 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure parting to moderate fine granular; friable; neutral; clear smooth boundary.
B—5 to 11 inches; very dark grayish brown (10YR 3/2) loam, dark brown (10YR 3/3) dry; weak fine granular structure; friable; about 2 percent coarse fragments, mostly pebbles of fragmented limestone; neutral; clear wavy boundary.
2C—11 to 42 inches; dark brown (10YR 4/3) very channery loam; massive; friable; about 65 percent coarse fragments, of which 15 percent is flagstones; loamy material in interstices is mildly alkaline; limestone fragments have slight effervescence; abrupt wavy boundary.
2R—42 inches; limestone bedrock.

The thickness of the solum and loamy sediments combined ranges from 8 to 18 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or silt loam. The B horizon has value of 3 through 5 and chroma of 2 through 4. It is loam, sandy clay loam, or clay loam. Reaction is slightly acid or neutral. The 2C horizon is 35 to 80 percent coarse fragments. Generally, the coarse fragments are limestone of channery size, but in some pedons flagstones are dominant. The loamy material between fragments has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 through 4.

Marshan series

The Marshan series consists of deep, poorly drained soils on outwash plains and stream terraces. They are moderately permeable in the upper part and rapidly permeable in the lower part. These soils formed in a silty and loamy mantle underlain by sand and gravelly deposits. Slopes range from 0 to 2 percent.

The Marshan soils are similar to the Kato and Mayer soils and are commonly adjacent to the slightly higher Cylinder soils and the higher Wadena soils. The Kato soils have more silt in the upper mantle. The Mayer soils are calcareous throughout the profile. The Cylinder soils are somewhat poorly drained, and the Wadena soils are well drained.

Typical pedon of Marshan silty clay loam, 1,820 feet north and 30 feet west of the southeast corner of sec. 15, T. 114 N., R. 19 W.

A1—0 to 6 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; moderate fine subangular blocky structure; friable; neutral; clear wavy boundary.
A2—6 to 14 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; friable; neutral; clear wavy boundary.
BA—14 to 18 inches; dark gray (10YR 4/1) loam; few fine faint yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; friable; neutral; clear wavy boundary.
Bg1—18 to 23 inches; grayish brown (2.5Y 5/2) loam high in silt; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; neutral; clear wavy boundary.
Bg2—23 to 28 inches; olive gray (5Y 5/2) loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; neutral; abrupt smooth boundary.
Bg3—28 to 32 inches; olive gray (5Y 4/2) loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; 5 percent coarse fragments; neutral; abrupt smooth boundary.
2C1—32 to 45 inches; light yellowish brown (10YR 6/4) sand; single grain; loose; 5 percent coarse fragments; neutral; clear irregular boundary.
2C2—45 to 60 inches; grayish brown (10YR 5/2) sand; single grain; loose; 5 percent coarse fragments; very slight effervescence; neutral.

The thickness of the solum ranges from 24 to 40 inches. Depth to free carbonates ranges from 50 to 75 inches. The upper part of the solum generally has no coarse fragments, but the lower part of the solum has about 20 percent coarse fragments. The mollic epipedon is 12 to 24 inches thick.

The A horizon has hue of 10YR, 2.5Y, or 5Y; value of 2 or 3; and chroma of 1 or 2, or it is N 2/0 or N 3/0. Texture generally is silty clay loam or loam, but the range includes clay loam or silt loam high in sand. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It has no distinct or prominent mottles in some pedons. Texture generally is clay loam or loam, but silt loam or silty clay loam high in sand content is within the range. Reaction is medium acid to neutral. The 2C horizon has value of 5 or 6 and chroma of 2 through 4. Texture generally is sand or gravelly sand, but in some pedons it is coarse sand and gravelly coarse sand. The 2C horizon is 5 to 50 percent coarse fragments.

Maxcreek series

The Maxcreek series consists of deep, poorly drained soils in slight depressions and heads of drainageways on end moraines. They are moderately permeable. These soils formed in silty sediments underlain by friable, loamy glacial till. Slopes range from 0 to 2 percent.

The Maxcreek soils are similar to the Garwin, Maxfield, and Webster soils and are commonly adjacent to the Le Sueur and Merton soils. The Le Sueur soils do not have a silty mantle and are slightly higher than the Maxcreek soils. The Merton soils are moderately well drained to somewhat poorly drained and are also higher on the landscape. The Garwin soils formed entirely in silty sediments. The Maxfield soils are underlain by firm glacial till. The Webster soils formed entirely in friable loamy glacial till.

Typical pedon of Maxcreek silty clay loam, 500 feet north and 2,550 feet east of the southwest corner of sec. 26, T. 113 N., R. 20 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.
A—8 to 13 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; neutral; abrupt smooth boundary.
AB—13 to 17 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; neutral; clear wavy boundary.
Bg1—17 to 22 inches; dark grayish brown (2.5Y 4/2) silty clay loam; few fine faint light olive brown (2.5Y 5/6) mottles; moderate medium subangular blocky structure; friable; neutral; clear wavy boundary.
Bg2—22 to 30 inches; grayish brown (2.5Y 5/2) silty clay loam; few fine faint gray (2.5Y 5/1) and light olive brown (2.5Y 5/6) mottles; moderate medium subangular blocky structure; friable; neutral; clear wavy boundary.
2C—30 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct gray (10YR 5/1) and yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; friable; 5 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and depth to free carbonates range from 26 to 48 inches. The thickness of the silty sediments ranges from 26 to 40 inches. The upper sediments generally do not have coarse fragments, but in some pedons coarse fragments are

about 1 percent of the volume. The mollic epipedon is 16 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. In some pedons it has mottles in the lower part of the horizon. The B horizon in both sediments has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The B horizon is silty clay loam in the upper part and silt loam or silty clay loam in the lower part. Some pedons have a 2B horizon that is loam or clay loam, but the upper 4 inches is sandy loam in some pedons. The B and 2B horizons generally are neutral, but the lower part of the 2B horizon in some pedons is mildly alkaline. The 2C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 through 4. It is generally loam, but sandy clay loam and sandy loam are in the range.

Maxfield series

The Maxfield series consists of deep, poorly drained soils at the heads of drainageways on uplands. They are moderately permeable. These soils formed in loess and the underlying firm glacial till. Slopes range from 0 to 2 percent.

The Maxfield soils are similar to the Garwin and Maxcreek soils and are commonly adjacent to the higher, somewhat poorly drained Klinger soils and the higher, well drained Ostrander soils. The Garwin soils do not have glacial till within 5 feet of the surface. The Maxcreek soils formed in a silty mantle underlain by friable glacial till.

Typical pedon of Maxfield silty clay loam, 630 feet south and 20 feet east of the northwest corner of sec. 20, T. 113 N., R. 19 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A—9 to 15 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; neutral; clear wavy boundary.

AB—15 to 21 inches; very dark gray (10YR 3/1) silty clay loam, dark brown (10YR 3/3) dry; weak fine subangular blocky structure; friable; neutral; abrupt wavy boundary.

Bg—21 to 27 inches; grayish brown (2.5Y 5/2) silty clay loam; few medium and fine distinct yellowish brown (10YR 6/6 and 10YR 6/8) mottles; weak medium subangular blocky structure; friable; neutral; abrupt wavy boundary.

2B1—27 to 36 inches; yellowish brown (10YR 5/6) loam; common fine faint grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; firm; about 5 percent coarse fragments; neutral; clear wavy boundary.

2B2—36 to 42 inches; yellowish brown (10YR 5/6) loam; common fine faint grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; friable; about 8 percent coarse fragments; neutral; clear wavy boundary.

2C—42 to 60 inches; yellowish brown (10YR 5/6) loam; common fine faint grayish brown (10YR 5/2) and few fine faint light gray (10YR 6/1) mottles; massive; firm; about 8 percent coarse fragments; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 36 to 55 inches. Carbonates are at a depth of 40 to 60 inches. Loess is generally 24 to 60 inches deep but ranges from 18 to 42 inches. In some pedons a stone line or a thin sandy lens is at a depth of 24 to 40 inches. This lens of coarser textured material is as much as 10 inches thick and occurs between the loess and glacial till.

The A horizon has value of 2 or 3, or it is N 2/0. Texture is silty clay loam or silt loam. The B horizon has hue of 2.5Y or 5Y and value of 4 or 5. Few to many mottles of high chroma are in the upper part of the B horizon. Texture is silty clay loam or silt loam. Reaction ranges from neutral to slightly acid. The 2B horizon has hue of 10YR or 7.5Y and chroma of 4 through 8. The 2C horizon has the same colors and textures as the 2B horizon.

Mayer series

The Mayer series consists of deep, poorly drained and very poorly drained soils on outwash plains and stream terraces. They are moderately permeable in the upper part and rapidly permeable in the lower part. These soils formed in a silty and loamy mantle and the underlying sandy and gravelly deposits. Slopes range from 0 to 2 percent.

The Mayer soils are similar to the Marshan soils and are commonly adjacent to the slightly higher, somewhat poorly drained Cylinder soils and the higher, well drained Wadena soils. The Marshan soils do not have free carbonates in the solum and occur in the more flood-prone adjacent areas.

Typical pedon from an area of Mayer silt loam, 100 feet south and 350 feet west of the northeast corner of sec. 21, T. 114 N., R. 19 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, black (10YR 2/1) dry; moderate fine subangular blocky structure; friable; strong effervescence; mildly alkaline; abrupt smooth boundary.

A—8 to 17 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; common fine faint dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; friable; strong effervescence; mildly alkaline; clear wavy boundary.

B—17 to 27 inches; grayish brown (2.5Y 5/2) loam; common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; slight effervescence; mildly alkaline; clear smooth boundary.
2BC—27 to 31 inches; olive (5Y 5/3) sandy loam; common fine distinct yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; very friable; slight effervescence; 10 percent coarse fragments; mildly alkaline; clear smooth boundary.
2C—31 to 60 inches; brown (10YR 4/3) gravelly loamy sand; single grain; loose; strong effervescence; 25 percent coarse fragments; mildly alkaline.

The thickness of the solum and depth to sandy and gravelly material range from 20 to 40 inches. The mollic epipedon is from 14 to 24 inches thick. Coarse fragments of mixed lithology range from 0 to 15 percent in the upper mantle and 10 to 50 percent in the underlying sediments.

The A horizon has hue of 10YR, 2.5Y, or 5Y and value of 2 or 3, or it is N 2/0 or N 3/0. Texture is loam or silt loam. The B horizon has hue of 10YR, 2.5Y, or 5Y; value of 4 or 5; and chroma of 1 through 3, or it is N 4/0 or N 5/0. Texture is loam, sandy clay loam, or silt loam. Some pedons do not have a 2BC horizon. Reaction of the B horizon is mildly alkaline or moderately alkaline. The 2C horizon has hue of 10YR, 2.5Y, or 5Y; value of 3 through 5; and chroma of 1 through 3. Texture generally is gravelly sand or gravelly loamy sand, but it includes strata of sand in some pedons. It is commonly calcareous throughout, although the upper part is noncalcareous in some places.

Merton series

The Merton series consists of deep, moderately well drained and somewhat poorly drained soils on loess-covered end moraines. They are moderately permeable. These soils formed in a mantle of loess and friable, loamy glacial till. Slopes range from 1 to 6 percent.

The Merton soils are similar to Klinger and Le Sueur soils and are commonly adjacent to the higher, well drained Blooming soils and the lower, poorly drained Maxcreek soils. The Klinger soils formed in a mantle of loess underlain by firm glacial till. The Le Sueur soils formed entirely in friable glacial till.

Typical pedon of Merton silt loam, 1 to 6 percent slopes, 500 feet west and 100 feet south of the northeast corner of sec. 26, T. 112 N., R. 20 W.

Ap—0 to 9 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; strong medium granular structure; friable; neutral; abrupt smooth boundary.
AB—9 to 15 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
2Bt1—15 to 22 inches; dark grayish brown (2.5Y 4/2) loam; weak medium subangular blocky structure; friable; few thin clay films on faces of peds; 3 percent coarse fragments; neutral; clear wavy boundary.
2Bt2—22 to 29 inches; dark grayish brown (2.5Y 4/2) loam high in sand; few fine distinct strong brown (7.5YR 5/6) and grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; friable; few thin clay films on faces of peds; 3 percent coarse fragments; neutral; clear wavy boundary.
2Bt3—29 to 37 inches; dark grayish brown (2.5Y 4/2) loam; few fine distinct strong brown (7.5YR 5/6) and common medium faint grayish brown (2.5Y 5/2) mottles; weak medium subangular blocky structure; friable; few thin clay films on faces of peds; 2 percent coarse fragments; neutral; clear wavy boundary.
2BC—37 to 50 inches; light olive brown (2.5Y 5/4) loam; few fine distinct strong brown (7.5YR 5/6) and few fine faint grayish brown (2.5Y 5/2) mottles; weak medium to coarse subangular blocky structure; friable; 3 percent coarse fragments; neutral; clear wavy boundary.
2C—50 to 60 inches; light olive brown (2.5Y 5/4) loam; few fine distinct strong brown (7.5YR 5/6) and few fine faint grayish brown (2.5Y 5/2) mottles; massive; friable; 4 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and depth to free carbonates generally range from 36 to 66 inches. The upper sediment over glacial till is 14 to 24 inches thick. This sediment is less than 1 percent coarse fragments. The underlying till generally is 2 to 8 percent, by volume, coarse fragments. The mollic epipedon ranges from 12 to 18 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It generally is silt loam or silty clay loam, but loam high in silt is within the range. Some pedons have a B horizon in the upper silty sediment. The 2B horizon generally has hue of 2.5Y, value of 4 or 5, and chroma of 2 through 4, but has hue of 10YR in a few pedons. It does not have mottles in some pedons, and in others it has faint mottles in the upper part and faint to prominent mottles in the lower part. Texture is loam or clay loam, but in some pedons a thin, coarser textured or partially sorted subhorizon is in the upper part. Reaction in the 2B horizon ranges from medium acid through neutral. The 2C horizon has value of 4 or 5 and chroma of 2 through 5. It is loam or sandy loam.

Minneiska series

The Minneiska series consists of deep, moderately well drained soils on flood plains of major rivers. They are moderately rapidly permeable. These soils formed in

recent stratified loamy alluvium. Slopes range from 0 to 2 percent.

The Minneiska soils are similar to the Lawson soils and are commonly adjacent to the lower Colo soils that have a thick, black surface horizon and to the lower, very poorly drained Oshawa soils. The Lawson soils formed mostly in silt loam material that is not stratified.

Typical pedon of Minneiska loam, occasionally flooded, 600 feet south and 50 feet west of the center of sec. 28, T. 28 N., R. 28 W.

A—0 to 8 inches; stratified very dark grayish brown (10YR 3/2), dark brown (10YR 4/3), and brown (10YR 5/3) loam, silt loam, and very fine sandy loam; dark grayish brown to light brownish gray (10YR 4/2 to 10YR 6/2) dry; finely stratified; very friable; slight effervescence; moderately alkaline; abrupt smooth boundary.

C1—8 to 29 inches; stratified dark grayish brown (10YR 4/2) loam and loamy fine sand; few fine faint yellowish brown (10YR 5/6) mottles; moderately thick platy structure; very friable; slight effervescence; moderately alkaline; abrupt smooth boundary.

C2—29 to 60 inches; dark grayish brown (10YR 4/2) very fine sandy loam and loamy fine sand with strata of silt loam; few fine faint yellowish brown (10YR 5/6) mottles; moderately thick platy strata parting to weak fine subangular blocky structure; very friable; slight effervescence; moderately alkaline.

The profile is made up of stratified alluvial sediments of varying color and texture. Most pedons are dominantly loam but contain strata of silt loam, loamy fine sand, fine sandy loam, loamy sand, fine sand, very fine sandy loam, and sand. It has value of 2 through 5 and chroma of 2 or 3. Some pedons have no mottles in the lower part of the control section. Reaction is mildly alkaline or moderately alkaline.

Oshawa series

The Oshawa series consists of deep, very poorly drained soils on flood plains of major rivers. They are moderately slowly permeable. These soils formed in silty alluvium. Slopes range from 0 to 1 percent.

The Oshawa soils are similar to the Colo and Kalmarville soils. They are commonly adjacent to the higher, moderately well drained Minneiska soils and to the Seelyeville soils, which are made up of organic material. The Colo soils do not have carbonates. The Kalmarville soils are underlain by sandy material.

Typical pedon of Oshawa silty clay loam, 0 to 2 percent slopes, 600 feet west and 900 feet north of the center of sec. 28, T. 28 N., R. 23 W.

A1g—0 to 9 inches; very dark gray (5Y 3/1) silty clay loam, dark gray (5Y 4/1) dry; strong fine angular blocky structure; friable; slight effervescence; mildly alkaline; clear wavy boundary.

A2g—9 to 19 inches; very dark gray (5Y 3/1) silty clay loam, dark gray (5Y 4/1) dry; moderate medium prismatic structure parting to moderate fine subangular blocky; friable; slight effervescence; mildly alkaline, gradual wavy boundary.

A3g—19 to 37 inches; very dark gray (5Y 3/1) silty clay loam, dark gray (5Y 4/1) dry; common fine distinct yellowish brown (10YR 5/8) mottles; moderate medium prismatic structure parting to moderate fine subangular blocky; friable; strong effervescence; mildly alkaline; gradual wavy boundary.

Cg—37 to 60 inches; dark gray (5Y 4/1) silty clay loam; common fine distinct yellowish brown (10YR 5/8) mottles; massive; friable; strong effervescence; mildly alkaline.

The A horizon ranges from 24 to 48 inches or more in thickness. It has value of 2 or 3 and chroma of 1 or 2. Texture is silty clay loam, clay loam, loam, or silt loam. Fragments of snail shells make up as much as 10 percent of the volume in some pedons. The A horizon is mildly alkaline or moderately alkaline. 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 generally loam, silt loam, silty clay loam, or clay loam, but coarser textured strata are common.

Ostrander series

The Ostrander series consists of deep, well drained soils on upland till plains. They are moderately permeable. These soils formed in loamy surficial sediments and the underlying calcareous, firm, loamy glacial till. Slopes range from 1 to 12 percent.

The Ostrander soils are similar to the Lester and Winnebago soils and are commonly adjacent to the Klinger and Maxfield soils. The Lester soils formed in friable glacial till. The Winnebago soils have redder hues in the subsoil. The Klinger soils are somewhat poorly drained and are downslope from the Ostrander soils. The Maxfield soils are poorly drained and occur at heads of broad, shallow drainageways.

Typical pedon of Ostrander loam, 1 to 6 percent slopes, 640 feet west and 425 feet south of center of sec. 20, T. 113 N., R. 19 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; friable; slightly acid; abrupt smooth boundary.

A—9 to 13 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; weak very fine subangular blocky structure; friable; slightly acid; clear wavy boundary.

AB—13 to 17 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; friable; slightly acid; clear wavy boundary.
2B1—17 to 31 inches; yellowish brown (10YR 5/6) loam; moderate medium subangular blocky structure; firm; about 5 percent coarse fragments; neutral; clear wavy boundary.
2B2—31 to 53 inches; yellowish brown (10YR 5/6) loam; moderate very coarse prismatic structure parting to moderate medium angular blocky; firm; about 5 percent coarse fragments; neutral; clear wavy boundary.
2C—53 to 60 inches; yellowish brown (10YR 5/6) loam; massive; firm; about 5 percent coarse fragments; strong effervescence; few soft white accumulations of carbonate; moderately alkaline.

The thickness of the solum and depth to free carbonates generally range from 45 to 66 inches. The mollic epipedon is 10 to 20 inches thick. In some pedons a stone line 2 and 6 inches thick that is up to 30 percent coarse fragments separates the sediments and the underlying glacial till. Below the stone line, coarse fragments range from 5 to 15 percent, by volume, throughout the 2B horizon and 2C horizon.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 through 3. It is silt loam or loam. Some pedons have an AB or BA horizon. The 2B horizon generally has hue of 10YR but ranges to 2.5Y in some pedons. It has value of 4 or 5 and chroma of 3 through 6. Texture is loam or clay loam. Reaction in the B horizon ranges from strongly acid to neutral. The 2C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 3 through 8.

Otterholt series

The Otterholt series consists of deep, well drained soils on end moraines. They are moderately permeable. These soils formed in loess underlain by loamy glacial till. Slopes range from 1 to 15 percent.

The Otterholt soils in Dakota County do not have tongues of albic material in the upper part of the B horizon and have a higher base saturation than is defined as the range for the series. These differences do not alter the usefulness or behavior of the soils.

The Otterholt soils are similar to the Crystal Lake, Jewett, and Spencer soils and are commonly adjacent to the Auburndale and Kingsley soils. The Auburndale soils are poorly drained and are in closed depressions. The Kingsley soils do not have a silty surface mantle and are similar in position to the Otterholt soils. The Crystal Lake soils are moderately well drained and formed in silty sediments more than 5 feet deep. The Jewett soils have a thinner layer of silty sediments. The Spencer soils are moderately well drained.

Typical pedon of Otterholt silt loam, 1 to 6 percent slopes, 1,800 feet south and 750 feet west of the northeast corner of sec. 13, T. 115 N., R. 20 W.

A—0 to 2 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/1) dry; moderate fine granular structure; very friable; medium acid; abrupt wavy boundary.
E1—2 to 7 inches; brown (10YR 4/3) silt loam, very pale brown (10YR 7/3) dry; weak very thin platy structure; very friable; strongly acid; clear wavy boundary.
E2—7 to 11 inches; brown (10YR 4/3) silt loam, very pale brown (10YR 7/4) dry; moderate thin platy structure; very friable; strongly acid; clear wavy boundary.
BE—11 to 15 inches; dark yellowish brown (10YR 4/4) silt loam; weak medium subangular blocky structure parting to moderate fine subangular blocky; firm; strongly acid; abrupt wavy boundary.
Bt1—15 to 26 inches; dark yellowish brown (10YR 5/4) silt loam; weak medium subangular blocky structure parting to strong fine subangular blocky; continuous thin clay films; firm; strongly acid; clear wavy boundary.
Bt2—26 to 35 inches; dark yellowish brown (10YR 4/4) silt loam, weak medium subangular blocky structure parting to strong fine subangular blocky; continuous thin to moderate clay films; firm; strongly acid; clear wavy boundary.
2C1—35 to 48 inches; reddish brown (5YR 4/4) sandy loam; massive; friable; 10 percent coarse fragments; slightly acid; clear wavy boundary.
2C2—48 to 60 inches; dark brown (7.5YR 4/4) loam; massive; friable; 10 percent coarse fragments; slightly acid.

The thickness of the solum generally is 30 to 40 inches and ranges to as much as 48 inches. The thickness of the loess mantle generally is 30 to 48 inches and ranges to 60 inches.

The A horizon has value and chroma of 2 or 3. The E horizon has value of 4 through 6 and chroma of 2 or 3. The B horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. Reaction is medium acid to strongly acid. The C horizon has hue of 2.5YR, 5YR, or 7.5YR and value and chroma of 4 or 5. It is sandy loam or loam and is 5 to 20 percent coarse fragments.

Palms series

The Palms series consists of deep, very poorly drained soils in upland depressions and along the Minnesota River flood plain. They are moderately slowly permeable to moderately permeable. These soils formed in highly decomposed herbaceous plant material underlain by loamy mineral deposits at a depth of 16 to 50 inches. Slopes range from 0 to 2 percent.

The Palms soils are similar to the Boots and Seelyeville soils. They are commonly adjacent to the Seelyeville soils on the Minnesota River flood plain and to the Glencoe and Mayer soils on uplands. The Glencoe soils formed in loamy glacial till, and the Mayer soils formed in mineral sediments underlain by sand and gravel. The Boots and Seelyeville soils do not have mineral deposits in the upper 50 inches. The Boots soils also have hemic material dominant in the control section.

Typical pedon of Palms muck, 800 feet east and 600 feet north of the southwest corner of sec. 29, T. 112 N., R. 20 W.

Oa1—0 to 38 inches; black (10YR 2/1) sapric material; weak medium platy structure; very friable; about 50 percent mineral material; slightly acid; clear smooth boundary.
Oa2—38 to 45 inches; black (N 2/0) sapric material; massive; very friable; about 60 percent mineral material; slightly acid; abrupt smooth boundary.
2Ab—45 to 56 inches; black (N 2/0) clay loam high in organic matter; massive; friable; slightly acid; clear smooth boundary.
2Cg—56 to 60 inches; dark gray (5Y 4/1) clay loam; few fine prominent yellowish red (5YR 4/6) mottles; massive; friable; slightly acid.

The depth to the loamy underlying material ranges from 16 to 50 inches. The reaction in the organic part of the control section below the surface tier ranges from strongly acid to mildly alkaline.

The surface tier has chroma of 1 or 2. It is sapric material, but some pedons have either sapric or hemic material or both in varying proportions. The organic part of the subsurface and bottom tiers has hue of 5YR, 7.5YR, or 10YR; value of 2 or 3; and chroma of 1 through 3, or it is N 2/0. The organic material in these tiers is dominantly sapric material; however, hemic material may total as much as 10 inches. The 2Ab horizon has hue of 10YR, value of 2, and chroma of 1 or 2, or it is N 2/0. It is clay loam, loam, silt loam, or fine sandy loam. Some pedons have no 2Ab horizon. The 2C horizon has hue of 10YR, 2.5Y, or 5Y; value of 4 through 7; and chroma of 1 or 2. It is silt loam, fine sandy loam, loam, or clay loam.

Plainfield series

The Plainfield series consists of deep, excessively drained soils on outwash plains and stream terraces. They are moderately rapidly permeable in the upper part and rapidly permeable in the lower part. These formed in sandy outwash. Slopes range from 0 to 18 percent.

The Plainfield soils are similar to the Gotham and Hubbard soils and are commonly adjacent to Dickinson, Hubbard, and Sparta soils. The Dickinson soils have a loamy surface layer and subsoil. The Gotham soils have an argillic horizon. The Hubbard soils have a mollic epipedon. The Sparta soils also have a mollic epipedon, but they formed in finer textured sand. All of these soils are in similar positions on the landscape.

Typical pedon of Plainfield loamy sand, 2 to 6 percent slopes, 920 feet north and 760 feet west of southeast corner of sec. 28, T. 114 N., R. 16 W.

A—0 to 4 inches; very dark brown (10YR 2/2) loamy sand, dark brown (10YR 4/3) dry; weak fine subangular blocky structure; very friable; slightly acid; abrupt wavy boundary.
B—4 to 14 inches; dark yellowish brown (10YR 4/4) sand; weak medium subangular blocky structure; very friable; medium acid; gradual smooth boundary.
BC—14 to 28 inches; yellowish brown (10YR 5/4) sand; single grain; loose; medium acid; gradual wavy boundary.
C1—28 to 36 inches; yellowish brown (10YR 5/6) sand; single grain; loose; medium acid; gradual wavy boundary.
C2—36 to 45 inches; brownish yellow (10YR 6/6) sand; single grain; loose; medium acid; gradual wavy boundary.
C3—45 to 60 inches; light yellowish brown (10YR 6/4) sand; single grain; loose; medium acid.

The thickness of the solum generally is 18 to 34 inches.

The A horizon has value of 2 or 3. If there is an Ap horizon, it has value of 3 or 4 and chroma of 2 or 3. The A horizon is sand, loamy sand, fine sand, or loamy fine sand. The B horizon has hue of 10YR or 7.5YR, value of 4 or more, and chroma of 3 through 6. Reaction of the B horizon is very strongly acid to neutral. The C horizon has hue of 10YR or 7.5YR, value of 5 to 7, and chroma of 4 through 8.

Port Byron series

The Port Byron series consists of deep, well drained soils on silt-mantled uplands. They are moderately permeable. These soils formed in deep loess. Slopes range from 0 to 12 percent.

The Port Byron soils are similar to the Tallula soils and are commonly adjacent to the lower, poorly drained Garwin soils and the lower, somewhat poorly drained Joy soils. The Tallula soils formed in coarse silt and contain carbonates at a shallower depth.

Typical pedon of Port Byron silt loam, 0 to 2 percent slopes, 1,000 feet east and 1,250 feet north of the southwest corner of sec. 5, T. 114 N., R. 16 W.

Ap—0 to 9 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; friable; medium acid; abrupt smooth boundary.

A—9 to 14 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; medium acid; clear smooth boundary.
AB—14 to 19 inches; very dark grayish brown (10YR 3/2) silt loam, dark brown (10YR 4/3) dry; moderate fine subangular blocky structure; friable; thin discontinuous brown (10YR 4/3) coatings in root channels; medium acid; clear wavy boundary.
Bw1—19 to 27 inches; dark yellowish brown (10YR 4/4) silt loam; moderate fine subangular blocky structure; friable; thin discontinuous very dark grayish brown (10YR 3/2) and dark brown (10YR 4/3) coatings in root channels and on faces of peds; medium acid; clear wavy boundary.
Bw2—27 to 46 inches; dark yellowish brown (10YR 4/4) silt loam; moderate medium subangular blocky structure; friable; thin continuous dark brown (10YR 4/3) and (7.5YR 4/4) coatings on faces of peds; medium acid; clear smooth boundary.
Bw3—46 to 52 inches; dark yellowish brown (10YR 4/4) silt loam; few fine distinct dark brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; friable; medium acid; clear smooth boundary.
C—52 to 60 inches; dark yellowish brown (10YR 4/4) silt loam; common fine distinct dark brown (7.5YR 4/4) mottles; massive; friable; thin discontinuous dark brown (10YR 4/3) coatings in root channels; medium acid.

The thickness of the solum ranges from 36 to 60 inches. The mollic epipedon is 10 to 24 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 through 3. The B horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 through 5. In some pedons the lower part of the B horizon does not have mottles. Reaction ranges from medium acid to neutral.

Quam series

The Quam series consists of deep, very poorly drained soils in closed depressions on end moraines. They are moderately permeable in the upper part and moderately slowly permeable in the lower part. These soils formed in more than 60 inches of silty eolian or lacustrine sediments. Slope ranges from 0 to 4 percent.

The Quam soils in Dakota County have a layer of recent overwash sediments 15 to 30 inches thick and are more acid than is defined as the range for this series. These differences do not alter the usefulness or behavior of the soils.

The Quam soils are similar to the Colo and Garwin soils and are commonly adjacent to the Kingsley, Otterholt, and Spencer soils. The Kingsley soils are well drained and steeper than the Quam soils, and they formed in sandy loam glacial till. The higher, well drained Otterholt soils and the higher, moderately well drained Spencer soils formed in a silty mantle underlain by sandy loam glacial till. The poorly drained Colo soils are in upland swales and drainageways and do not have a buried horizon. The Garwin soils do not have a cumulic mollic epipedon and buried surface horizon.

Typical pedon of Quam silt loam, 900 feet south and 1,050 feet east of the northwest corner of sec. 23, T. 27 N., R. 23 W.

A1—0 to 12 inches; very dark grayish brown (10YR 3/1) silt loam, grayish brown (10YR 5/1) dry; weak medium platy structure parting to weak fine subangular blocky; very friable; medium acid; clear smooth boundary.
A2—12 to 19 inches; very dark grayish brown (10YR 3/1) silt loam, grayish brown (10YR 5/1) dry; weak medium platy structure parting to weak fine subangular blocky; very friable; medium acid; abrupt smooth boundary.
Ab1—19 to 32 inches; block (N 2/0) silt loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; very friable; strongly acid; clear wavy boundary.
Ab2—32 to 45 inches; black (10YR 2/1) silt loam, gray (10YR 5/1) dry; subangular blocky structure; friable; strongly acid; clear wavy boundary.
Cg—45 to 60 inches; grayish brown (2.5Y 5/2) silt loam; few fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; medium acid.

The thickness of the mollic epipedon ranges from 24 to 60 inches.

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. It has mottles in some pedons. Generally, it is silt loam or silty clay loam, but subhorizons of loam, clay loam, or silty clay are included in the range. The lower part of some pedons is 0 to 5 percent coarse fragments. Reaction is strongly acid to slightly acid. Some pedons do not have an Ab horizon. Also, some pedons have a B horizon up to 24 inches thick. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. In some pedons it has no mottles. It is loam, silt loam, silty clay loam, or clay loam. Coarse fragments range from 0 to 8 percent.

Rockton series

The Rockton series consists of moderately deep, well drained soils on dissected uplands. They are moderately permeable. These soils formed in a mantle of loamy glacial drift underlain by limestone bedrock. Slopes range from 0 to 12 percent.

The Rockton soils are commonly adjacent to the Copaston and Marlean soils. The Copaston soils are more shallow to bedrock than the Rockton soils and are in similar positions on the landscape. The Marlean soils are underlain by up to 12 feet of fragmented limestone, and they are steeper than the Rockton soils.

Typical pedon of Rockton loam, 2 to 6 percent slopes, 1,250 feet north and 100 feet east of center of sec. 18, T. 115 N., R. 17 W.

A—0 to 13 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to moderate fine granular; friable; slightly acid; clear smooth boundary.
AB—13 to 16 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; friable; slightly acid; clear wavy boundary.
Bt1—16 to 22 inches; dark brown (10YR 4/3) clay loam; moderate fine subangular blocky structure; friable; very dark brown (10YR 2/2) coatings in pores; common thin clay films on faces of peds; medium acid; clear wavy boundary.
Bt2—22 to 31 inches; dark brown (10YR 4/3) clay loam; moderate fine subangular blocky structure; friable; few thin clay films on faces of peds; medium acid; clear wavy boundary.
2Bt3—31 to 35 inches; dark brown (10YR 4/3) clay loam; weak fine subangular blocky structure; firm; very few thin clay films on faces of peds; medium acid; abrupt wavy boundary.
2R—35 inches; fractured limestone bedrock.

The thickness of the solum and depth to bedrock range from 20 to 40 inches. The mollic epipedon is 10 to 18 inches thick. The volume of coarse fragments of mixed lithology ranges from 0 to 8 percent.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or silt loam. The B horizon has hue of 10YR in the upper part and hue of 10YR, 7.5YR, or 5YR in the lower part, value of 4 or 5, and chroma of 3 or 4. It is loam, clay loam, or sandy clay loam. The 2B horizon is similar to the B horizon in hue, value, and chroma. It is clay loam, silty clay loam, clay, or silty clay. Reaction in the B horizon ranges from strongly acid in the upper part to neutral in the 2B horizon. The bedrock is generally limestone, but in a few pedons it is cemented sandstone. Generally, the boundary between the solum and the bedrock is abrupt, but a thin layer of disintegrated limestone or discontinuous residuum is at the contact in some pedons.

Rondeau series

The Rondeau series consists of deep, very poorly drained soils along the Minnesota River flood plain and in upland depressions. They are moderately slowly permeable in the upper part and slowly permeable in the lower part. These soils formed in highly decomposed organic materials underlain by limnic materials. Slopes range from 0 to 2 percent.

The Rondeau soils are similar to the Boots, Palms, and Seelyeville soils and are commonly adjacent to them. All these soils are similar in position on the landscape. The Boots soils have hemic material dominant in the control section, the Palms soils have mineral material above 51 inches, and the Seelyeville soils have sapric material dominant to a depth of more than 51 inches.

Typical pedon of Rondeau muck, 0 to 2 percent slopes, 420 feet north and 1,020 feet west of the southeast corner of sec. 32, T. 27 N., R. 24 W.

Oa1—0 to 10 inches; black (10YR 2/1) sapric material; weak fine granular structure; very friable; less than 5 percent fiber; about 40 percent mineral material; slight effervescence; mildly alkaline; diffuse wavy boundary.
Oa2—10 to 38 inches; black (10YR 2/1) sapric material; massive; very friable; less than 5 percent fiber; about 45 percent mineral material; slight effervescence; mildly alkaline; diffuse wavy boundary.
Oa3—38 to 45 inches; black (10YR 2/1) sapric material; massive; very friable; less than 5 percent fiber; about 45 percent mineral material; slight effervescence; mildly alkaline; abrupt smooth boundary.
Ck1—45 to 49 inches; gray (10YR 5/1) marl; massive; friable; about 10 percent shells and shell fragments; about 55 percent calcium carbonate equivalents; violent effervescence; mildly alkaline; abrupt smooth boundary.
Ck2—49 to 60 inches; light gray (10YR 7/1) marl; massive; friable; about 90 percent calcium carbonate equivalents; violent effervescence; moderately alkaline.

The depth to marl ranges from 16 to 51 inches. A thin layer of coprogenous earth as much as 10 inches in thickness is between the organic material and the marl in some pedons. The organic material is 20 to 45 percent mineral material. The surface tier and the organic part of the lower tiers generally are sapric material, but hemic material is as thick as 10 inches in some pedons. The reaction in the lower tiers is strongly acid through mildly alkaline. The sapric material has value of 2 or 3 and chroma of 1 or 2 on the broken face. The hemic material has value of 2 through 4 and chroma of 2 to 3 on the broken face. The Ck layer has hue of 10YR, 2.5Y, or 5Y; value of 5 through 7; and chroma of 1 or 2. It is 80 to 98 percent mineral material, and more than half of it is calcium carbonate. Some pedons have a C layer that has hue of 10YR, 2.5Y, or 5Y; value of 2 through 4; and chroma of 1 or 2, or it is N 2/0 through N 4/0.

Salida series

The Salida series consists of deep, excessively drained soils on outwash plains and stream terraces. They are very rapidly permeable. These soils formed in a

thin loamy mantle underlain by calcareous sandy and gravelly deposits. Slopes range from 2 to 12 percent.

The Salida soils are similar to the Emmert soils and are commonly adjacent to Estherville and Kanaranzi soils. The Estherville soils have fewer coarse fragments, and the Kanaranzi soils have a finer textured surface layer than the Salida soils. The Emmert soils do not have free carbonates and are on end moraines. The Salida, Estherville, and Kanaranzi soils are in similar positions on the landscape.

Typical pedon of Salida gravelly coarse sandy loam, 2 to 12 percent slopes, 300 feet south and 2,340 feet east of the northwest corner of sec. 8, T. 112 N., R. 18 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) gravelly coarse sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; 40 percent coarse fragments; neutral; abrupt smooth boundary.
Bw—8 to 14 inches; dark brown (10YR 4/3) gravelly loamy coarse sand; single grain; loose; 40 percent coarse fragments; neutral; clear wavy boundary.
C1—14 to 20 inches; dark brown (10YR 4/3) very gravelly sand; single grain; loose; 50 percent coarse fragments; strong effervescence; mildly alkaline; clear wavy boundary.
C2—20 to 60 inches; brown (10YR 5/3) gravelly sand; single grain; loose; 35 percent coarse fragments; strong effervescence; mildly alkaline.

The solum generally is 7 to 20 inches thick. The mollic epipedon ranges from 7 to 14 inches in thickness. The solum is 35 to 75 percent coarse fragments.

The A horizon has value of 2 or 3 and chroma of 1 through 3. It is gravelly sandy loam, gravelly coarse sandy loam, gravelly loamy sand, gravelly loamy coarse sand, or gravelly coarse sand. In a few pedons this horizon is less than 15 percent coarse fragments. The B horizon commonly is discontinuous. It has value of 3 or 4 and chroma of 3 or 4. It is commonly gravelly loamy sand, gravelly loamy coarse sand, gravelly coarse sand, or gravelly sand. Reaction ranges from slightly acid through mildly alkaline. The C horizon has hue of 10YR or 7.5YR, value of 3 through 6, and chroma of 2 through 6. It is generally gravelly coarse sand, gravelly sand, sandy gravel, or gravel.

Seelyeville series

The Seelyeville series consists of deep, very poorly drained soils along major flood plains and in upland depressions. They have moderately rapid permeability. These soils formed in highly decomposed organic material more than 51 inches thick. Slopes range from 0 to 2 percent.

The Seelyeville soils are similar to the Boots, Palms, and Rondeau soils and are commonly adjacent to them. All these soils are in similar positions on the landscape. The Boots soils have hemic material dominant in the control section, the Palms soils have mineral material above 51 inches, and the Rondeau soils have marl layers within 51 inches of the surface.

Typical pedon of Seelyeville muck, 1,055 feet north and 990 feet east of the center of sec. 19, T. 112 N., R. 20 W.

Oa1—0 to 6 inches; black (10YR 2/1) sapric material; weak fine granular structure; very friable; 40 percent mineral material; neutral; clear smooth boundary.
Oa2—6 to 28 inches; black (10YR 2/1) sapric material; weak thin platy structure; very friable; 20 percent mineral material; neutral; abrupt smooth boundary.
Oe—28 to 31 inches; very dark grayish brown (10YR 3/2) hemic material; moderate medium platy structure; very friable; 15 percent mineral material; neutral; abrupt smooth boundary.
Oa—31 to 60 inches; black (10YR 2/1) sapric material; weak thin platy structure; very friable; 10 percent mineral matter; few thin strata of limnic sediments; neutral.

Mineral material ranges from 10 to 40 percent throughout the control section. The surface tier generally is made up entirely of sapric materials, but in some pedons hemic materials are included. The subsurface and bottom tiers are sapric material, but hemic material as much as 10 inches thick is within these tiers. These hemic layers mainly are in the upper part of the subsurface horizon. Reaction in the lower tiers is strongly acid to mildly alkaline. The sapric material has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2 on the broken face. The hemic material has value and chroma of 2 or 3 on the broken face.

Sparta series

The Sparta series consists of deep, excessively drained soils on stream terraces and outwash plains. They are moderately rapidly permeable in the upper part and rapidly permeable in the lower part. These soils formed in sandy alluvium. Slopes range from 1 to 6 percent.

The Sparta soils are similar to the Gotham soils and are commonly adjacent to the Gotham and Hubbard soils. They are also commonly adjacent to the lower Zumbro soils. The Gotham soils do not have a mollic epipedon. The Hubbard soils contain 50 percent or more medium and coarse sand in the solum. The Zumbro soils have a mollic epipedon at least 24 inches thick. The Sparta, Gotham, and Hubbard soils are in similar positions on the landscape.

Typical pedon of Sparta loamy fine sand, 1 to 6 percent slopes, 1,890 feet west of the northeast corner of sec. 22, T. 114 N., R. 17 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; weak fine granular structure; loose; medium acid; clear smooth boundary.
AB—8 to 10 inches; dark brown (10YR 3/3) loamy fine sand, dark brown (10YR 4/3) dry; weak fine subangular blocky structure; loose; medium acid; clear wavy boundary.
Bw1—10 to 13 inches; dark yellowish brown (10YR 4/4) loamy fine sand; weak fine subangular blocky structure; loose; strongly acid; clear wavy boundary.
Bw2—13 to 25 inches; dark yellowish brown (10YR 4/4) fine sand; single grain; loose: strongly acid; clear wavy boundary.
C—25 to 60 inches; yellowish brown (10YR 5/4) fine sand; single grain; loose; medium acid.

The thickness of the solum ranges from 24 to 40 inches. The mollic epipedon is 10 to 24 inches thick. The control section has an average of 30 percent or more fine sand or finer particles and 20 percent or less coarse sand and very coarse sand.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2. Texture is loamy sand, loamy fine sand, or sand. The AB horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 or 3. Texture is sand, fine sand, loamy sand, or loamy fine sand. The B horizon has hue of 10YR or 7.5YR and value and chroma of 3 through 6. Texture is sand, fine sand, loamy sand, or loamy fine sand. Reaction is medium acid or strongly acid. The C horizon has hue of 10YR or 7.5YR, value of 4 through 6, and chroma of 3 through 6. Texture is sand or fine sand.

Spencer series

The Spencer series consists of deep, moderately well drained soils on end moraines. They are moderately permeable. These soils formed in a silty mantle underlain by loamy glacial till. Slopes range from 2 to 6 percent.

The Spencer soils in Dakota County do not have tongues of albic material in the upper part of the B horizon and have a higher base saturation than is defined as the range for the series. These differences do not alter the usefulness or behavior of this soil.

The Spencer soils are similar to the Crystal Lake soils and are commonly adjacent to the higher, well drained Jewett, Kingsley, and Otterholt soils. The Crystal Lake soils do not have glacial till within a depth of 5 feet.

Typical pedon of Spencer silt loam, 2 to 6 percent slopes, 1,290 feet east and 460 feet north of the southwest corner of sec. 14, T. 27 N., R. 22 W.

A—0 to 7 inches; dark grayish brown (10YR 4/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; neutral; abrupt wavy boundary.
E—7 to 13 inches; dark grayish brown (10YR 4/2) silt loam; weak thin platy structure; very friable; slightly acid, abrupt wavy boundary.
Bt1—13 to 20 inches; yellowish brown (10YR 5/4) silt loam; weak fine subangular blocky structure; friable, few thin clay films on faces of peds; medium acid; clear wavy boundary.
Bt2—20 to 35 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate fine subangular blocky structure; firm; common thin continuous clay films on faces of peds; medium acid; clear wavy boundary.
Bw—35 to 45 inches; yellowish brown (10YR 5/4) silt loam high in very fine sand; few fine faint dark grayish brown (10YR 4/2) mottles; weak fine subangular blocky structure; friable; medium acid; clear wavy boundary.
2C—45 to 60 inches; dark brown (7.5YR 4/4) sandy loam; few fine distinct dark grayish brown (10YR 4/2) mottles; massive; friable; 15 percent coarse fragments; slightly acid.

The silty material is generally 30 to 48 inches thick but can range to 60 inches. The solum is 30 to 48 inches thick. Some pedons have a gravel lag line 3 to 8 inches thick at the contact between the silty upper mantle and the underlying glacial till.

The A horizon has value of 2 through 4 and chroma of 1 or 2. Where there is an Ap horizon, it has value of 4 or 5 and chroma of 2 to 3. The E horizon has value of 4 or 5 and chroma of 2 or 3. The B horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. Clay films range from thin to thick in the Bt horizon. Texture is silt loam or silty clay loam. Mottles range from distinct to faint in the lower part of the B horizon. The 2C horizon has hue of 5YR or 7.5YR and value and chroma of 4 to 5. Texture is sandy loam or loam. Coarse fragments in the glacial till range from 5 to 20 percent, by volume.

Spillville series

The Spillville series consists of deep, moderately well drained and somewhat poorly drained soils in upland drainageways. They are moderately permeable. These soils formed in loamy alluvium. Slopes range from 0 to 3 percent.

Spillville soils are similar to the Kennebec soils. The Kennebec soils have more silt and less sand throughout the profile.

Typical pedon of Spillvile loam, occasionally flooded, 1,080 feet north and 1,100 feet west of the southeast corner of sec. 14, T. 27 N., R. 22 W.

A1—0 to 12 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; slightly acid; gradual smooth boundary.

A2—12 to 30 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
A3—30 to 48 inches; very dark brown (10YR 2/2) loam high in silt, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
A4—48 to 60 inches; very dark grayish brown (10YR 3/2) loam high in silt, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; neutral.

The thickness of the solum is generally about 40 inches. It ranges from 30 to 60 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Texture is loam or silt loam in the upper 36 inches. Below a depth of 36 inches the texture is generally loam but ranges to sandy loam or clay loam.

Tallula series

The Tallula series consists of deep, well drained soils on uplands. They are moderately permeable. These soils formed in deep loess. Slopes range from 2 to 12 percent.

The Tallula soils are similar to the Port Byron and Timula soils and are commonly adjacent to the Port Byron, Timula, and Bold soils. The Port Byron soils have more clay in the solum than the Tallula soils. The Timula and Bold soils do not have a mollic epipedon. All of these soils are in similar positions on the landscape.

Typical pedon of Tallula silt loam, 2 to 6 percent slopes, 1,500 feet south and 300 feet east of the northwest corner of sec. 18, T. 113 N., R. 17 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.
Bw—9 to 22 inches; yellowish brown (10YR 5/4) silt loam; moderate fine subangular blocky structure; friable; neutral; clear smooth boundary.
BC—22 to 27 inches; yellowish brown (10YR 5/4) silt loam; weak fine subangular blocky structure; friable; mildly alkaline; clear smooth boundary.
C—27 to 60 inches; yellowish brown (10YR 5/6) silt loam; few fine distinct yellowish brown (10YR 5/8) mottles; massive; very friable; strong effervescence; mildly alkaline.

The thickness of the solum and depth to free carbonates range from 18 to 35 inches.

The A horizon ranges from 7 to 20 inches thick. It has value of 2 or 3 and chroma of 1 through 3. The B horizon has value of 4 or 5 and chroma of 3 or 4. Reaction ranges from neutral to mildly alkaline. The C horizon has value of 5 or 6 and chroma of 3 to 6. It is silt or silt loam. Some pedons do not have mottles in the C horizon.

Terril series

The Terril series consists of deep, moderately well drained soils on uplands. They are moderately permeable. These soils formed in loamy alluvium and colluvium derived from glacial till. Slopes range from 4 to 12 percent.

The Terril soils are similar to the Lindstrom soils. The Lindstrom soils have less sand and more silt in the solum than the Terril soils and are in the upper part of small drainageways on uplands.

Typical pedon of Terril loam, 4 to 12 percent slopes, 100 feet west and 1,900 feet north of the southeast corner of sec. 16, T. 112 N., R. 19 W.

A1—0 to 7 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; neutral; abrupt smooth boundary.
A2—7 to 20 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine and medium granular structure; very friable; neutral; clear wavy boundary.
A3—20 to 36 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; friable; neutral; clear wavy boundary.
Bw—36 to 48 inches; very dark grayish brown (10YR 3/2) loam, dark brown (10YR 3/3) dry; weak medium subangular blocky structure; friable; neutral; clear wavy boundary.
C—48 to 60 inches; dark brown (10YR 4/3) loam; massive; friable; neutral.

The thickness of the solum ranges from 36 to 60 inches. The mollic epipedon is 24 to 36 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Texture is loam, silt loam, or clay loam. The B horizon has value of 3 or 4 and chroma of 2 through 4. Texture is loam or clay loam. Reaction is slightly acid or neutral. The C horizon has value of 4 or 5 and chroma of 3 or 4.

Timula series

The Timula series consists of deep, well drained soils on loess-mantled uplands. They are moderately permeable. These soils formed in loess. Slopes range from 6 to 25 percent.

The Timula soils in Dakota County are mapped only in complex with the Bold soils. The Timula soils are similar to the Bold, Port Byron, and Tallula soils and commonly are adjacent to them. All of these soils are in similar positions on the landscape. The Bold soils have a lighter colored surface layer than the Timula soils, and the Port

Byron and Tallula soils have a thicker, darker colored surface layer.

Typical pedon of Timula silt loam, from an area of Timula-Bold silt loams, 12 to 18 percent slopes, 2,000 feet west and 900 feet south of the northeast corner of sec. 13, T. 113 N., R. 19 W.

Ap—0 to 8 inches; dark brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; moderate medium granular structure; friable; neutral; abrupt smooth boundary.
Bw—8 to 20 inches; yellowish brown (10YR 5/4) silt loam; weak fine subangular blocky structure; friable; mildly alkaline; clear smooth boundary.
C—20 to 60 inches; yellowish brown (10YR 5/6) silt loam; massive; very friable; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 18 to 36 inches.

The A horizon has value of 3 through 5 and chroma of 2 through 4. The B horizon has value of 4 through 6 and chroma of 4 through 6. The C horizon is similar in color and texture to the B horizon. Reaction ranges from slightly acid to moderately alkaline.

Wadena series

The Wadena series consists of deep, well drained soils on outwash plains and stream terraces. They are moderately permeable in the upper part and rapidly permeable in the lower part. These soils formed in a loamy mantle and the underlying sandy and gravelly deposits. Slopes range from 0 to 18 percent.

The Wadena soils are similar to the Dickinson and Waukegan soils and are commonly adjacent to the Estherville and Kanaranzi soils. The Dickinson soils have a coarser textured solum. The Waukegan soils have more silt and less sand in the solum. The Estherville soils have less clay in the solum, and the Kanaranzi soils have a thinner solum than the Wadena soils. The Wadena, Estherville, and Kanaranzi soils are in similar positions on the landscape.

Typical pedon of Wadena loam, 0 to 2 percent slopes, 60 feet south and 800 feet east of the northwest corner of sec. 22, T. 114 N., R. 18 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark brown (10YR 3/1) dry; weak fine granular structure; friable; neutral; clear smooth boundary.
A—8 to 12 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; very friable; neutral; clear smooth boundary.
AB—12 to 16 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; very friable; slightly acid; clear wavy boundary.
Bw1—16 to 21 inches; dark brown (10YR 4/3) loam; moderate coarse subangular blocky structure; very friable; medium acid; clear smooth boundary.
Bw2—21 to 26 inches; dark brown (10YR 4/3) loam; moderate coarse subangular blocky structure; friable; slightly acid; clear smooth boundary.
Bw3—26 to 31 inches; dark yellowish brown (10YR 4/4) sandy loam; weak coarse subangular blocky structure; friable; neutral; abrupt smooth boundary.
2BC—31 to 35 inches; dark yellowish brown (10YR 4/4) loamy sand; single grain; very friable; neutral; clear smooth boundary.
2C—35 to 60 inches; dark yellowish brown (10YR 4/4) and brown (10YR 5/3) sand; single grain; loose; 5 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and depth to the 2C horizon range from 24 to 40 inches. The mollic epipedon ranges from 12 to 20 inches in thickness. Depth to free carbonates is 30 to 50 inches. Generally, coarse fragments range from 0 to 15 percent, by volume, in the loamy mantle and from 5 to 50 percent in the underlying material.

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 in the upper part and 10YR or 7.5YR in the lower part; value of 3 through 5; and chroma of 3 or 4. It is loam or clay loam in the upper part and coarse sandy loam, sandy loam, sandy clay, or loam in the lower part. Reaction ranges from medium acid to neutral. The 2BC horizon has texture of loamy coarse sand, loamy sand, coarse sandy loam, or sandy loam. Some pedons do not have a 2BC horizon. The 2C horizon has hue of 10YR or 7.5YR, value of 4 through 6, and chroma of 2 through 4. It is coarse sand or sand.

Waukegan series

The Waukegan series consists of deep, well drained soils on outwash plains and stream terraces. They are moderately permeable in the upper part and rapidly permeable in the lower part. These soils formed in a silty mantle and the underlying calcareous sandy and gravelly deposits. Slopes range from 0 to 12 percent.

The Waukegan soils are similar to the Wadena soils and are commonly adjacent to the Estherville and Cylinder soils. The Wadena soils have more sand and less silt in the solum. The Cylinder soils are somewhat poorly drained and are slightly lower on the landscape, and the Estherville soils are excessively drained and have less clay in the solum than the Waukegan soils. The Waukegan and Estherville soils are in similar positions on the landscape.

Typical pedon of Waukegan silt loam, 0 to 1 percent slopes, 2,110 feet east and 80 feet south of the northwest corner of sec. 2, T. 114 N., R. 20 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; friable; slightly acid; clear smooth boundary.
AB—8 to 13 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; friable; medium acid; clear smooth boundary.
Bt1—13 to 18 inches; dark brown (10YR 4/3) silt loam; moderate medium subangular blocky structure; friable; few thin clay films on faces of peds; medium acid; clear smooth boundary.
Bt2—18 to 28 inches; dark yellowish brown (10YR 4/4) silt loam; moderate medium subangular blocky structure; friable; few thin clay films on faces of peds; medium acid; clear smooth boundary.
2BC1-28 to 32 inches; dark yellowish brown (10YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; 5 percent coarse fragments; slightly acid; clear smooth boundary.
2BC2—32 to 42 inches; dark yellowish brown (10YR 4/4) gravelly coarse sand; single grain; loose; 15 percent coarse fragments; neutral; clear smooth boundary.
2C—42 to 60 inches; yellowish brown (10YR 5/4) gravelly sand; single grain; loose; 25 percent coarse fragments; strong effervescence; mildly alkaline.

The thickness of the solum generally ranges from 36 to 55 inches. The thickness of the upper silty mantle ranges from 20 to 40 inches. Depth to free carbonates is 40 to 70 inches. The mollic epipedon is 12 to 20 inches thick. Limestone bedrock is at a depth of 40 to 60 inches in some pedons.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Texture is silt loam, silty clay loam, or loam high in silt and very fine sand. The B horizon has hue of 10YR in the upper part and hue of 10YR or 2.5Y in the lower part. It has value and chroma of 3 through 5. Texture is silt loam, silty clay loam, or loam high in silt and very fine sand. Some pedons do not have clay films. Reaction in the B horizon ranges from strongly acid to neutral. The 2BC horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 3 through 6. Texture includes coarse sand, sand, loamy coarse sand, loamy sand, coarse sandy loam, sandy loam, or gravelly coarse sand. The 2C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 through 6. Texture is coarse sand or sand or their gravelly analogs. Coarse fragments in the 2BC and 2C horizons range from 0 to 50 percent. Some pedons have limestone bedrock between 40 and 60 inches.

Webster series

The Webster series consists of deep, poorly drained soils on end moraines. They are moderately permeable. These soils formed in friable, loamy glacial till. Slopes range from 0 to 2 percent.

The Webster soils are similar to the Cordova and Maxcreek soils and are commonly adjacent to the slightly higher Cordova soils, the lower Glencoe soils, and the higher Le Sueur soils. The Cordova soils but have an argillic horizon. The Glencoe soils are very poorly drained, and the Le Sueur soils are moderately well drained to somewhat poorly drained. The Maxcreek soils formed in a silty mantle underlain by friable till and are in the upper part of upland drainageways.

Typical pedon of Webster clay loam, 1,090 feet north and 1,000 feet west of the southeast corner of sec. 16, T. 112 N., R. 20 W.

Ap—0 to 8 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; moderate fine granular structure; very friable; neutral; abrupt smooth boundary.
A—8 to 14 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; friable; neutral; clear wavy boundary.
Bg1—14 to 17 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; 3 percent coarse fragments; neutral; clear wavy boundary.
Bg2—17 to 22 inches; grayish brown (2.5Y 5/2) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; 5 percent coarse fragments; neutral; clear wavy boundary.
Bg3—22 to 30 inches; grayish brown (2.5Y 5/2) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; 5 percent coarse fragments; neutral; clear wavy boundary.
Cg1—30 to 45 inches; grayish brown (2.5Y 5/2) clay loam; many fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; 5 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.
Cg2—45 to 60 inches; grayish brown (2.5Y 5/2) clay loam; many medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; 5 percent coarse fragments; strong effervescence; mildly alkaline.

The thickness of the solum generally ranges from 24 to 36 inches, but it is as much as 50 inches in some pedons. The depth to free carbonates is about the same as the solum thickness, although in some pedons there is a B3 horizon that contains free carbonates. Coarse fragments make up about 2 to 8 percent of the volume of the control section, but in some pedons the upper 2 feet or less is less than 2 percent coarse fragments.

The A horizon is 10YR 2/1 or N 2/0. It is clay loam or silty clay loam. The B horizon has hue of 5Y or 2.5Y,

value of 4 or 5, and chroma of 1 or 2. Mottles of either high or low chroma or both range from few to common throughout the B horizon. The texture is clay loam or silty clay loam. Reaction ranges from neutral to mildly alkaline. Colors of the C horizon are similar to those of the B horizon, but some pedons have chroma of 3 and value as high as 6 in part of the matrix. Generally, the C horizon is clay loam, but in some pedons it is loam or sandy loam.

Winnebago series

The Winnebago series consists of deep, well drained soils on upland till plains. They are moderately permeable. These soils formed in loamy surficial sediments and the underlying loamy glacial till. Slopes range from 2 to 6 percent.

The Winnebago soils are similar to the Ostrander soils and are commonly adjacent to the Ostrander, Carmi, and Klinger soils. The Ostrander soils do not have an argillic horizon. The Carmi soils have less clay in the solum than the Winnebago soils. The Klinger soils are somewhat poorly drained and are downslope from the Winnebago soils. The Winnebago, Ostrander, and Carmi soils are in similar positions on the landscape.

Typical pedon of Winnebago loam, 2 to 6 percent slopes, 1,000 feet north and 20 feet west of the southeast corner of sec. 35, T. 114 N., R. 17 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; neutral; abrupt smooth boundary.

A—9 to 15 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; friable; neutral; abrupt wavy boundary.

2Bt1—15 to 22 inches; dark reddish brown (5YR 3/4) sandy clay loam; strong medium subangular blocky structure; firm; few thin reddish brown (5Y 4/4) clay films on faces of peds; 4 percent coarse fragments; slightly acid; clear wavy boundary.

2Bt2—22 to 35 inches; yellowish red (5YR 4/6) sandy clay loam; strong very coarse prismatic structure parting to strong coarse and medium subangular blocky; firm; continuous moderately thick reddish brown (5YR 4/4) clay films on faces of peds; common medium dark concretions (Mn oxides); 5 percent coarse fragments; slightly acid; clear wavy boundary.

2Bt3—35 to 40 inches; yellowish red (5YR 4/6) sandy clay loam; strong very coarse prismatic structure parting to moderate medium subangular blocky; firm; few thin dark reddish brown (5YR 3/4) clay films on faces of peds; common fine dark concretions (Mn oxides); 4 percent coarse fragments; medium acid; clear smooth boundary.

2BC—40 to 44 inches; reddish brown (5YR 4/4) sandy clay loam; weak medium subangular blocky structure; firm; few thin dark reddish brown (5YR 3/4) clay films on faces of peds; many medium dark concretions (Mn oxides); 4 percent coarse fragments; slightly acid; clear wavy boundary.

2C—44 to 60 inches; reddish brown (5YR 4/4) sandy loam; massive; friable; 5 percent coarse fragments; slightly acid.

The thickness of the solum ranges from 40 to 60 inches. The mollic epipedon ranges from 10 to 18 inches in thickness. In some pedons a stone line between 1 and 4 inches thick, containing up to 30 percent coarse fragments, separates the loamy upper sediments and the underlying till.

The A horizon has value of 2 or 3 and chroma of 1 through 3. It is silt loam or loam. Some pedons have an AB or BA horizon. The 2B horizon has hue of 7.5YR or 5YR, value of 3 through 5, and chroma of 3 through 6. Texture ranges from clay loam to sandy clay loam, loam, or sandy loam. Reaction in the 2B horizon ranges from strongly acid to slightly acid. Coarse fragments range from 2 to 15 percent, by volume. The 2C horizon has hue of 7.5YR or 5YR, value of 4 through 6, and chroma of 3 through 6. It is sandy loam, loam, or sandy clay loam. Coarse fragments range from 2 to 15 percent, by volume.

Zumbro series

The Zumbro series consists of deep, moderately well drained and well drained soils on flood plains and drainageways on outwash plains. They are rapidly permeable. These soils formed in loamy and sandy alluvium several feet thick. Slopes range from 0 to 2 percent. This soil is rarely flooded.

The Zumbro soils are similar to the Algansee soils and are commonly adjacent to the Algansee and Kalmarville soils along major flood plains and to the Hubbard, Sparta, and Wadena soils on outwash plains. The Algansee soils, which are similar in position to the Zumbro soils, are somewhat poorly drained. The Hubbard, Sparta, and Wadena soils have a thinner mollic epipedon, do not flood, and are higher on the landscape than the Zumbro soils. The Kalmarville soils are poorly drained and very poorly drained and are lower on the landscape than the Zumbro soils.

Typical pedon of Zumbro fine sandy loam, 1,200 feet east and 1,080 feet south of the northwest corner of sec. 22, T. 112 N., R. 19 W.

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

A1—10 to 18 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; very friable; neutral; diffuse wavy boundary.
A2—18 to 40 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; very friable; mildly alkaline; diffuse wavy boundary.
A3—40 to 56 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; very friable; mildly alkaline; diffuse wavy boundary.
B—56 to 60 inches; dark brown (10YR 4/3) fine sand, dark grayish brown (10YR 4/2) dry; massive; very friable; mildly alkaline.

The thickness of the solum ranges from 26 to 60 inches. The mollic epipedon ranges from 24 to 50 inches thick. Depth to free carbonates generally is 20 to 60 inches. Coarse fragments make up 0 to 15 percent of the solum and C horizon.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Texture is loamy sand, loamy fine sand, sandy loam, or fine sandy loam. The B horizon has value and chroma of 2 to 4. Texture is sand, fine sand, loamy sand, or loamy fine sand. Reaction is slightly acid to mildly alkaline. Where there is a C horizon above a depth of 60 inches, the value is 5 or 6 and chroma is 2 to 5. Texture is coarse sand, sand, or fine sand.

formation of the soils

This section discusses the factors of soil formation and relates them to the formation of the soils in the survey area.

factors of soil formation

Soil formed through processes acting on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by: (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land, and; (5) the length of time the forces of soil formation have acted on the soil material (*5*).

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil profile. It may be much or little, but some time is always required for differentiations of soil horizons. Usually, a long time is required for the formation 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 of Dakota County formed mainly in glacial till, glacial outwash, loess, alluvium, and bedrock or its residuum.

Glacial till refers to drift that was deposited by continental glaciers. This drift is composed of an unsorted, heterogeneous mass of boulders, rock, sand, silt, and clay. Soils, such as the Durand, Kenyon, Kingsley, and Lester soils, formed in glacial drift.

Glacial outwash deposits formed from the melt water of disintegrating glacial ice. These deposits are mainly in the form of outwash plains and terraces. Soils in these areas commonly have a sandy and gravelly substratum and a sandy to silty upper layer. The Estherville, Hubbard, Kato, Wadena, and Waukegan soils are dominant in these areas.

Loess deposits cover much of the county. Loess is coarse and fine, silt-sized particles lifted and carried away from seasonally flooded outwash plains by strong winds. These wind-blown particles were then redeposited as a silty mantle a short distance downwind from the source areas. The Bold, Port Byron, and Tallula soils are examples of soils that formed in loess.

Alluvial sediments are on most flood plains and in stream valleys and their tributaries. These sediments are generally stratified and range in particle size from silts or clays to sands and cobbles. The Algansee, Lindstrom, Spillville, and Zumbro soils are alluvial soils.

Bedrock material is also a part of soils that occurs as outcroppings on valley walls, rock-cored terraces, and upland divides. The Copaston, Etter, and Frontenac soils were formed from weathering of limestone or sandstone. The Rockton soil is an example of a thin deposit of drift underlain by bedrock.

climate

Climate is an important factor in determining the kind of vegetation, animals, bacteria, and other organisms that persist in the soil. It determines the intensity of physical and chemical activities in the soil, mainly through the effects of precipitation and temperature. The effects of climate and vegetation vary according to relief, permeability, and the length of time the parent material has been in place.

Dakota County has a subhumid, continental climate that results in hot summers and cold winters. The climate is essentially uniform throughout the county.

plant and animal life

Plants, animals, bacteria and other organisms are active in the soil-forming process. They aid in the breakdown of parent material and in the formation of organic matter and also in the decomposition of organic matter. Vegetation affects soil formation by leaving residue on the soil and by transferring plant nutrients from the subsoil to the surface horizon. The kind of plants and animals that live on and in the soil is determined by the climate, parent material, relief, and the age of the soil.

Formation of Dakota County soils has been influenced by forest and prairie. The surface layer of soils that formed under forest is thinner and lighter in color than that of soils that formed under prairie. In forest soils the movement of clay and organic material downward into the subsoil is more than it is in prairie soils. Loamy soils that formed under forest vegetation have a light-colored subsurface layer just below the surface layer. The Kingsley soil is an example of a forested soil. The Port Byron soil, which has a thick, dark-colored surface layer, is an example of a prairie soil.

relief

Relief, or surface configuration of the land, is an important factor in the formation of soils. It affects the distribution of water, erosion, the movement of parent

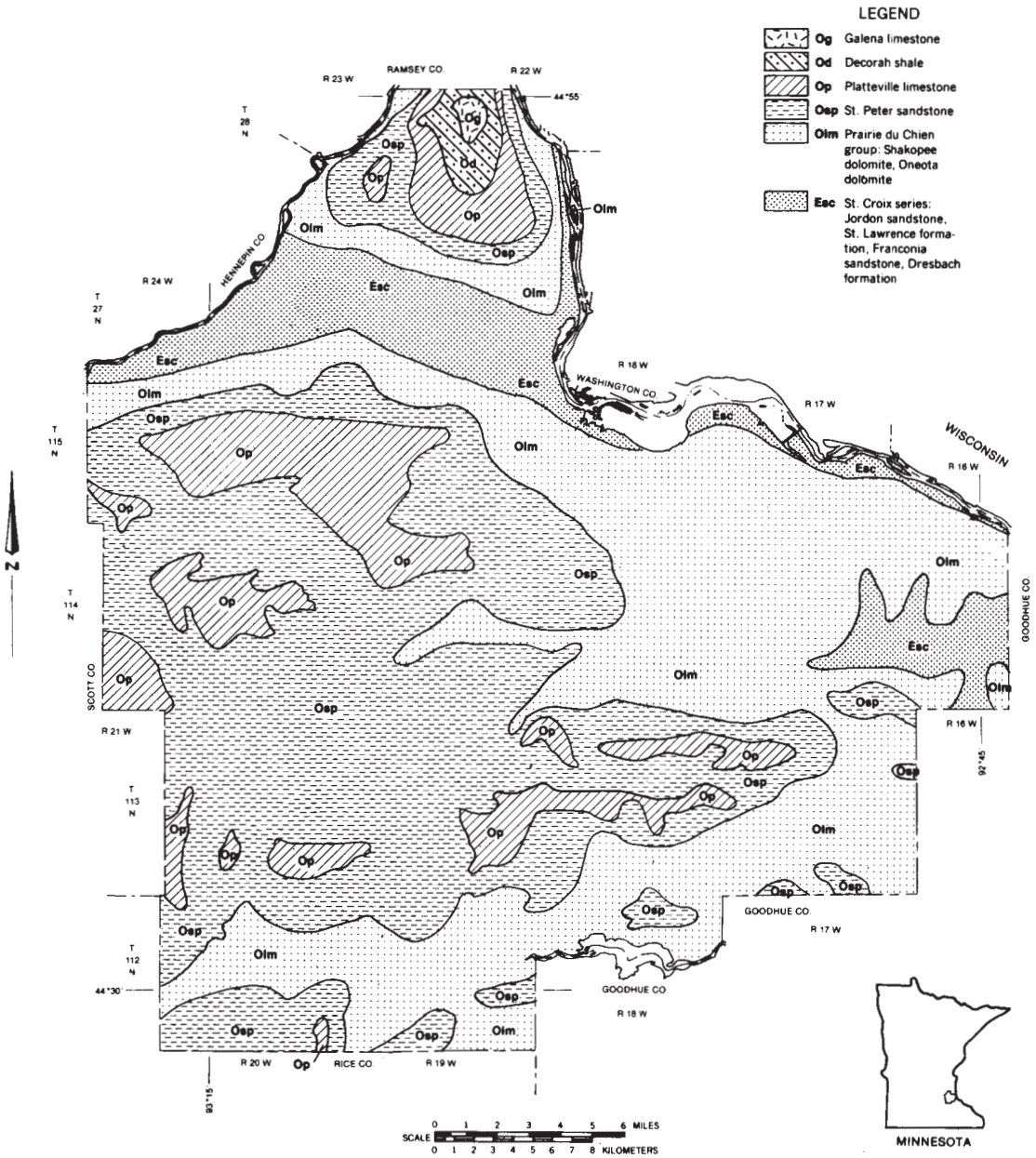


Figure 16.—Geologic map of Dakota County showing type and extent of bedrock.

material, soil moisture, and soil temperature. The sloping soils are generally more dry than the flat or concave soils because water runs off, and there is less leaching. Sloping soils, such as the Lester soils, are usually well drained and have good aeration and bright internal colors because of oxidation. A depressional area commonly has very slow internal water movement and has a high water table. Soils that formed in these low-lying, poorly drained depressions, such as the Garwin soils, have a thicker and darker surface layer and a higher organic matter content. Also, the subsoil has a dull grayish color and varying degrees of mottling.

Soil profiles are mostly strongly developed and have greater depth in gently sloping areas where internal drainage is good. The degree of profile development is mostly a function of the amount of water passing through the soil.

Relief affects the temperature of the soil by its exposure to the sun. South-facing slopes are warmer, and vegetation commonly is more sparse.

Soils saturated with water in depressions are slower to warm up in the spring because more heat is required for a cubic foot of waterlogged soil than for a cubic foot of dry soil. Cool temperatures and poor oxidation of poorly drained soils retard the micro-organism population. Organic soils, such as the Seelyeville and Palms soils, form in low, flat positions where drainage is very poor.

time

Soil characteristics are also determined by the length of time involved in the soil forming process. The age of the soil is characterized by changes in the morphology or appearance of the profile. Soluble materials are first leached out. Organic matter then begins to accumulate and initiates horizon development.

Soils in Dakota County are geologically young because the last glacial period ended some 10,000 years ago. A young soil has more natural plant nutrients and commonly is more fertile than an older, mature soil. A young soil has many properties of the parent material because forming processes have not had time to greatly alter this fresh material.

geology

The geology of Dakota County is complex and varied. The materials making up the landscape can be placed into three broad groups: Paleozoic sedimentary rocks, Pleistocene glacial sediments, and Recent sediments.

The entire county is underlain by sedimentary rocks that were deposited during the Paleozoic Era of geologic time, between about 600 million and 400 million years ago (fig. 16). These rocks were deposited on the bottoms and shores of shallow oceans that once covered this region. The lower layers formed during the Cambrian Period and are mostly sandstone and shale.

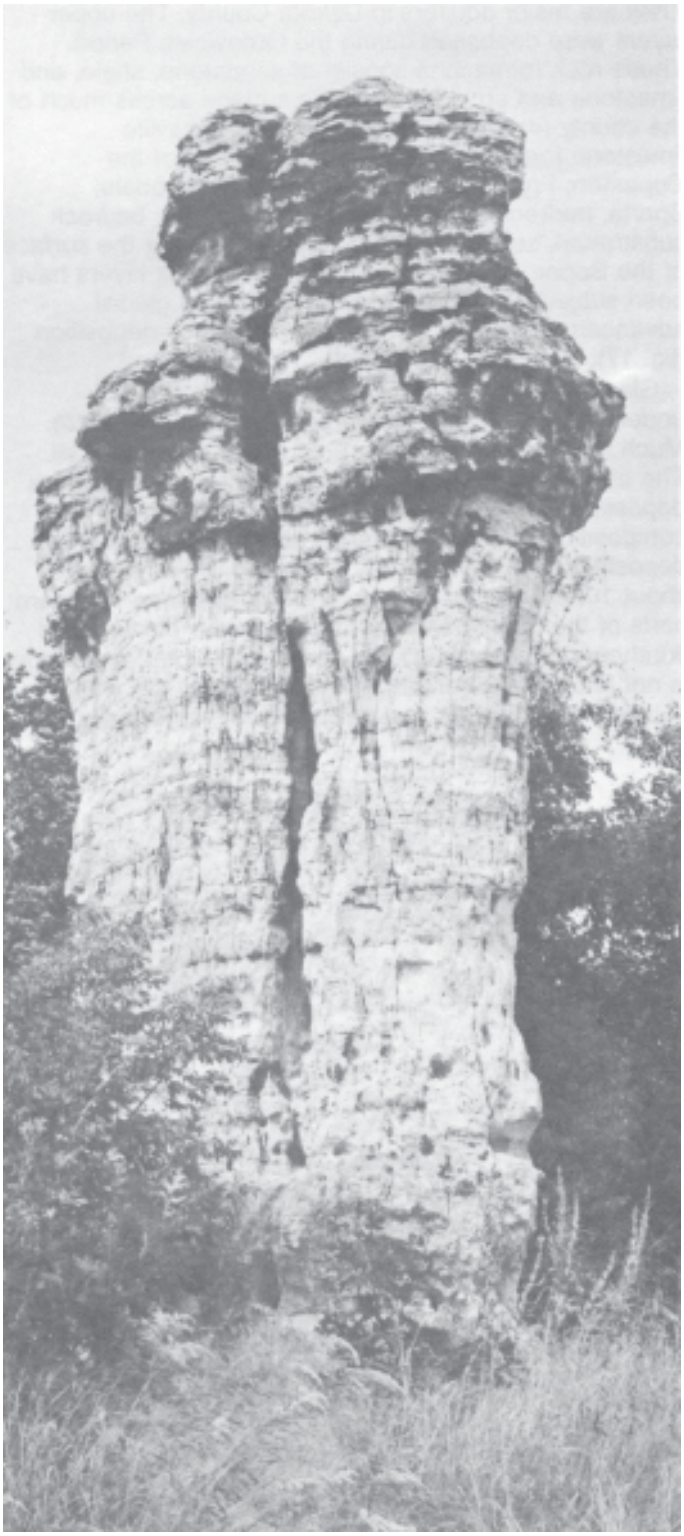


Figure 17.—Chimney Rock in the Etter-Brodale complex, 25 to 60 percent slopes, has withstood glacial advancement and thousands of years of weathering. This is a column of St. Peter sandstone with an erosion-resistant cap of Platteville limestone.

They are major aquifers in Dakota County. The upper layers were deposited during the Ordovician Period. These rock formations consist of sandstone, shale, and limestone and are at or near the surface across much of the county (*4*, *3*). The Shakopee and Platteville limestone formations are near the surface of the Copaston; Frontenac; Marlean; Rockton; Brodale; Sparta, bedrock substratum; and Waukegan, bedrock substratum, soils. St. Peter sandstone is near the surface of the Boone and Etter soils. These bedrock layers have been subjected to considerable erosion by glacial advancement and by weathering since their deposition (fig. 17).

Glacial sediments of the Pleistocene Epoch are underlain by bedrock in most parts of the county (*10*). Much of the upland areas are composed of glacial till. The till consists of loamy unsorted sediments that were deposited directly by the glaciers. The age and composition of glacial till varies across the county. Tills deposited by the Wisconsin Glaciation, which ended about 10,000 years ago, are in the northern and western parts of the county. Most of the tills in the eastern and southern parts of the county are older, but the exact age is not known with certainty. Reddish brown tills were deposited by glaciers that flowed from the northeast out of the Lake Superior basin. The Kingsley soils are an example of soils that formed in this material. Yellowish brown to light olive brown soils were deposited by glaciers that flowed from the northwest out of Canada. The Lester soils are an example of soils that formed in this material.

Large rivers were formed as the glaciers melted. These rivers deposited sandy outwash material in level to sloping areas across much of the county. The Plainfield soils are an example of soils that formed in this material. Loess, or wind-blown silt, was deposited across most of the county near the end of glaciation. The Port Byron soils are an example of soils that formed in this material.

Several kinds of sediment have been deposited during the last 10,000 years. Thick layers of loamy to silty alluvium have accumulated along major rivers and in side valley tributaries. The Kalmarville soils are an example of soils that formed in recent alluvium.

Also, organic soils that formed in decomposed plant remains are in very poorly drained depressions and on flood plains in several parts of Dakota County. The Seelyeville soils are an example of soils that formed in organic material.

references

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. I0, 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) Austin, George S. 1972. Paleozoic lithostratigraphy of southeastern Minnesota. *In* Geology of Minnesota: a centennial volume. pp. 459-473, illus. Minnesota Geol. Survey.

(4) Mossler, John H. 1972. Paleozoic struction and stratigraphy of the Twin City region. *In* Geology of Minnesota: a centennial volume. pp. 485-497, illus. Minnesota Geol. Survey.

(5) Ruhe, Robert V. 1956. Geomorphic surfaces and the nature of soils. Soil Sci. 82: 441-445, illus.

(6) United States Department of Agriculture. 1951. Soil survey manual. U. S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962]

(7) United States Department of Agriculture. 1960. Soil survey of Dakota County, Minnesota. Soil Conserv. Serv. and Minn. Agric. Exp. Sta. 52 pp., illus.

(8) 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. Hanb. 436, 754 pp., illus.

(9) Upham, Warren. 1969. Minnesota geographic names, their origin and historic significance. Reprint Ed., Minnesota Historical Society. Illus.

(10) Wright, H. E., Jr. 1972. Quaternary history of Minnesota. *In* Geology of Minnesota: a centennial volume. pp. 515-547, illus. Minnesota Geol. Survey.

This page intentionally left blank.

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.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

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

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	More than 12

Basal till. Compact glacial till deposited beneath the ice.

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bench terrace. A raised, level or nearly level strip of earth constructed on or nearly on a contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Broad-base terrace. A ridge-type terrace built to control erosion by diverting runoff along the contour at a nonscouring velocity. The terrace is 10 to 20 inches high and 15 to 30 feet wide and has gently sloping sides, a rounded crown, and a dish-shaped channel along the upper side. It may be nearly level or have a grade toward one or both ends.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

California bearing ratio (CBR). The load-supporting capacity of a soil as compared to that of a standard crushed limestone, expressed as a ratio. First standardized in California. A soil having a CBR of 16 supports 16 percent of the load that would be supported by standard crushed limestone, per unit area, with the same degree of distortion.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena. A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent material but have different characteristics as a result of differences in relief and drainage.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

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 fragment.

Chiseling. Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage to control soil blowing.

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) 15.2 to 38.1 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

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.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation 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.

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.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coprogenous earth (sedimentary peat). Fecal material deposited in water by aquatic organisms. The Lco horizon is a limnic layer that contains many fecal pellets.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or arresting grazing for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—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.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Esker (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 37.5 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.

Fragile (in tables). A soil that is easily damaged by use or disturbance.

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.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial 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.

Graded stripcropping. Growing crops in strips that grade toward a protected waterway.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 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 (7.5 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

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 upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an A, O, 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) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

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 A or B 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 the solum, the Arabic numeral 2 precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Landslide. The rapid downhill movement of a mass of soil and loose rock, generally when wet or saturated. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

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

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low 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. 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).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

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.

Open space. A relatively undeveloped green or wooded area provided mainly within an urban area to minimize feelings of congested living.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through 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 0.20 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.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Pitting (in tables). Pits caused by melting ground ice. They form on the soil after plant cover is removed.

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.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

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.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called 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.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Salty water (in tables.) Water that is too salty for consumption by livestock.

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.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

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.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Sinkhole. A depression in the landscape where limestone has been dissolved.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slippage (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake (in tables). The slow movement of water into the soil.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.5 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 mm 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, B, and E 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.

Stone line. A concentration of coarse fragments in a soil. Generally it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

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 horizon, including all subdivisions.

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.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till 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.

Tuff. A compacted deposit that is 50 percent or more volcanic ash and dust.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial melt water. In nonglaciated regions, alluvium deposited by heavily loaded 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.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Varve. A sedimentary layer or a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by melt water streams, in a glacial lake or other body of still water in front of a glacier.

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 diameteer. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soils.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

This page intentionally left blank.

tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-74 at Farmington, Minnesota]

Month	Temperature						Precipitation				
				2 years in 10 will have--				2 years in 10 will have--			
	Average daily maximum	Average daily minimum	Average daily	Maximum temperature higher than--	Minimum temperature lower than--	Average number of growing degree days*	Average	Less than--	More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	20.9	2.1	11.5	43	-31	0	0.76	0.29	1.13	2	7.8
February---	26.9	7.5	17.3	48	-23	0	.98	.29	1.53	3	8.6
March------	37.7	19.5	28.7	67	-13	12	1.73	.87	2.42	4	10.7
April------	56.3	34.9	45.6	87	15	48	2.20	1.35	2.95	6	2.2
May--------	69.5	46.7	58.1	92	26	269	3.56	2.21	4.77	9	.1
June-------	78.7	56.6	67.7	97	41	531	4.66	2.24	6.62	8	.0
July-------	82.5	60.6	71.6	96	46	670	4.30	2.66	5.76	7	.0
August-----	80.5	58.6	69.6	94	43	608	3.96	1.92	5.61	6	.0
September--	71.0	49.2	60.1	90	30	307	2.80	.96	4.26	6	.0
October----	60.9	39.6	50.3	87	19	140	2.22	.86	3.34	5	.3
November---	41.3	25.0	33.2	66	-3	0	1.34	.50	2.01	3	3.9
December---	27.0	10.8	18.9	51	-22	0	1.04	.37	1.57	3	8.3
Year-----	54.4	34.3	44.4	98	-31	2,585	29.55	24.49	34.36	62	41.9

* 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

[Recorded in the period 1951-74 at Farmington, Minnesota]

Probability	Dates for given probability and temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 27	May 7	May 19
2 years in 10 later than--	April 22	May 2	May 15
5 years in 10 later than--	April 11	April 23	May 6
First freezing temperature in fall:			
1 year in 10 earlier than--	October 13	October 1	September 25
2 years in 10 earlier than--	October 18	October 6	September 29
5 years in 10 earlier than--	October 29	October 16	October 6

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-74 at Farmington, Minnesota]

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	180	154	137
8 years in 10	186	161	142
5 years in 10	199	176	152
2 years in 10	212	190	163
1 year in 10	219	197	168

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
2B	Ostrander loam, 1 to 6 percent slopes	15,909	4.3
2C	Ostrander loam, 6 to 12 percent slopes	4,248	1.2
7A	Hubbard loamy sand, 0 to 1 percent slopes	755	0.2
7B	Hubbard loamy sand, 1 to 6 percent slopes	2,090	0.6
7C	Hubbard loamy sand, 6 to 12 percent slopes	936	0.3
7D	Hubbard loamy sand, 12 to 18 percent slopes	608	0.2
8A	Sparta loamy fine sand, 0 to 1 percent slopes	1,545	0.4
8B	Sparta loamy fine sand, 1 to 6 percent slopes	1,690	0.5
12C	Emmert very gravelly sandy loam, 3 to 15 percent slopes	320	0.1
27A	Dickinson sandy loam, 0 to 2 percent slopes	1,073	0.3
27B	Dickinson sandy loam, 2 to 6 percent slopes	4,193	1.1
39A	Wadena loam, 0 to 2 percent slopes	12,588	3.4
39B	Wadena loam, 2 to 6 percent slopes	19,737	5.2
39B2	Wadena loam, 2 to 6 percent slopes, eroded	2,526	0.7
39C	Wadena loam, 6 to 12 percent slopes	1,350	0.4
39C2	Wadena loam, 6 to 12 percent slopes, eroded	397	0.1
39D	Wadena loam, 12 to 18 percent slopes	283	0.1
41A	Estherville sandy loam, 0 to 2 percent slopes	3,941	1.1
41B	Estherville sandy loam, 2 to 6 percent slopes	6,764	1.8
42C	Salida gravelly coarse sandy loam, 2 to 12 percent slopes	496	0.1
49B	Antigo silt loam, 1 to 8 percent slopes	1,361	0.4
81B	Boone loamy fine sand, 2 to 6 percent slopes	988	0.3
81C	Boone loamy fine sand, 6 to 12 percent slopes	1,482	0.4
81E	Boone loamy fine sand, 12 to 40 percent slopes	618	0.2
94C	Terril loam, 4 to 12 percent slopes	1,373	0.4
98	Colo silt loam, occasionally flooded	3,540	1.0
100A	Copaston loam, 0 to 2 percent slopes	608	0.2
100B	Copaston loam, 2 to 6 percent slopes	1,643	0.4
100C	Copaston loam, 6 to 12 percent slopes	1,413	0.4
106B	Lester loam, 2 to 6 percent slopes	3,191	0.9
106C	Lester loam, 6 to 12 percent slopes	1,612	0.4
106C2	Lester loam, 6 to 12 percent slopes, eroded	886	0.2
106D2	Lester loam, 12 to 18 percent slopes, eroded	967	0.3
109	Cordova silty clay loam	1,494	0.4
113	Webster clay loam	2,016	0.5
114	Glencoe silty clay loam	2,007	0.5
129	Cylinder loam	8,156	2.2
150B	Spencer silt loam, 2 to 6 percent slopes	1,213	0.3
151C	Burkhardt sandy loam, 6 to 12 percent slopes	1,760	0.5
151D	Burkhardt sandy loam, 12 to 18 percent slopes	833	0.2
155B	Chetek sandy loam, 3 to 8 percent slopes	660	0.2
155C	Chetek sandy loam, 8 to 15 percent slopes	1,445	0.4
155E	Chetek sandy loam, 15 to 25 percent slopes	502	0.1
173F	Frontenac loam, 25 to 40 percent slopes	651	0.2
176	Garwin silty clay loam	2,633	0.7
177A	Gotham loamy fine sand, 0 to 2 percent slopes	601	0.2
177B	Gotham loamy fine sand, 2 to 6 percent slopes	553	0.2
177C	Gotham loamy fine sand, 6 to 12 percent slopes	318	0.1
189	Auburndale silt loam	938	0.3
203B	Joy silt loam, 1 to 5 percent slopes	802	0.2
208	Kato silty clay loam	2,544	0.7
213B	Klinger silt loam, 1 to 5 percent slopes	5,691	1.5
226	Lawson silt loam	398	0.1
239	Le Sueur loam	2,270	0.6
250	Kennebec silt loam	2,880	0.8
251D	Marlean loam, 12 to 18 percent slopes	674	0.2
251E	Marlean loam, 18 to 25 percent slopes	444	0.1
252	Marshan silty clay loam	8,909	2.4
253	Maxcreek silty clay loam	2,121	0.6
255	Mayer silt loam	3,165	0.9
279B	Otterholt silt loam, 1 to 6 percent slopes	1,885	0.5
279C	Otterholt silt loam, 6 to 15 percent slopes	404	0.1
283A	Plainfield loamy sand, 0 to 2 percent slopes	486	0.1
283B	Plainfield loamy sand, 2 to 6 percent slopes	1,536	0.4
283D	Plainfield loamy sand, 6 to 18 percent slopes	321	0.1
285A	Port Byron silt loam, 0 to 2 percent slopes	351	0.1
285B	Port Byron silt loam, 2 to 6 percent slopes	1,900	0.5
285C	Port Byron silt loam, 6 to 12 percent slopes	285	0.1
299A	Rockton loam, 0 to 2 percent slopes	1,234	0.3
299B	Rockton loam, 2 to 6 percent slopes	3,828	1.0
299C	Rockton loam, 6 to 12 percent slopes	1,218	0.3
301B	Lindstrom silt loam, 1 to 4 percent slopes	3,578	1.0

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
313	Spillville loam, occasionally flooded	1,085	0.3
317	Oshawa silty clay loam	407	0.1
318	Mayer loam, swales	990	0.3
320B	Tallula silt loam, 2 to 6 percent slopes	3,357	0.9
320C2	Tallula silt loam, 6 to 12 percent slopes, eroded	1,479	0.4
342B	Kingsley sandy loam, 3 to 8 percent slopes	4,487	1.2
342C	Kingsley sandy loam, 8 to 15 percent slopes	6,884	1.9
342E	Kingsley sandy loam, 15 to 25 percent slopes	2,618	0.7
342F	Kingsley sandy loam, 25 to 40 percent slopes	727	0.2
344	Quam silt loam	1,796	0.5
377B	Merton silt loam, 1 to 6 percent slopes	3,430	0.9
378	Maxfield silty clay loam	3,750	1.0
382B	Blooming silt loam, 1 to 6 percent slopes	4,075	1.1
408	Faxon silty clay loam	676	0.2
409B	Etter fine sandy loam, 2 to 6 percent slopes	5,477	1.5
409C	Etter fine sandy loam, 6 to 12 percent slopes	1,671	0.5
411A	Waukegan silt loam, 0 to 1 percent slopes	31,562	8.6
411B	Waukegan silt loam, 1 to 6 percent slopes	19,595	5.0
411C	Waukegan silt loam, 6 to 12 percent slopes	459	0.1
414	Hamel silt loam	628	0.2
415A	Kanaranzi loam, 0 to 2 percent slopes	3,072	0.8
415B	Kanaranzi loam, 2 to 6 percent slopes	4,895	1.3
415C	Kanaranzi loam, 6 to 12 percent slopes	733	0.2
449B	Crystal Lake silt loam, 1 to 8 percent slopes	710	0.2
454B	Mahtomedi loamy sand, 3 to 8 percent slopes	403	0.1
454C	Mahtomedi loamy sand, 8 to 15 percent slopes	1,099	0.3
454E	Mahtomedi loamy sand, 15 to 25 percent slopes	1,152	0.3
463	Minneiska loam, occasionally flooded	1,482	0.4
465	Kalmarville sandy loam, frequently flooded	1,393	0.4
495	Zumbro fine sandy loam	807	0.2
522	Boots muck	288	0.1
539	Palms muck	2,616	0.7
540	Seelyeville muck	2,903	0.8
545	Rondeau muck	423	0.1
611C	Hawick coarse sandy loam, 6 to 12 percent slopes	7,605	2.1
611D	Hawick coarse sandy loam, 12 to 18 percent slopes	1,941	0.5
611E	Hawick loamy sand, 18 to 25 percent slopes	1,242	0.3
611F	Hawick loamy sand, 25 to 50 percent slopes	1,287	0.3
857A	Urban land-Waukegan complex, 0 to 1 percent slopes	6,446	1.7
857B	Urban land-Waukegan complex, 1 to 8 percent slopes	2,817	0.8
858C	Urban land-Chetek complex, 1 to 15 percent slopes	3,202	0.9
860C	Urban land-Lester complex, 3 to 15 percent slopes	848	0.2
861C	Urban land-Kingsley complex, 3 to 15 percent slopes	4,339	1.2
861E	Urban land-Kingsley complex, 15 to 25 percent slopes	377	0.1
865B	Urban land-Hubbard complex, 0 to 6 percent slopes	939	0.3
880F	Brodale-Rock outcrop complex, 18 to 45 percent slopes	716	0.2
888B	Kingsley-Lester complex, 2 to 6 percent slopes	657	0.2
888C	Kingsley-Lester complex, 6 to 12 percent slopes	1,042	0.3
888D	Kingsley-Lester complex, 12 to 18 percent slopes	331	0.1
889B	Wadena-Hawick complex, 2 to 6 percent slopes	204	0.1
889C	Wadena-Hawick complex, 6 to 12 percent slopes	215	0.1
889D	Wadena-Hawick complex, 12 to 18 percent slopes	195	0.1
895B	Kingsley-Mahtomedi-Spencer complex, 3 to 8 percent slopes	3,354	0.9
895C	Kingsley-Mahtomedi-Spencer complex, 8 to 15 percent slopes	5,474	1.5
896E	Kingsley-Mahtomedi complex, 15 to 25 percent slopes	4,552	1.2
896F	Kingsley-Mahtomedi complex, 25 to 40 percent slopes	1,150	0.3
963C2	Timula-Bold silt loams, 6 to 12 percent slopes, eroded	1,034	0.3
963D2	Timula-Bold silt loams, 12 to 18 percent slopes, eroded	1,266	0.3
963E2	Timula-Bold silt loams, 18 to 25 percent slopes, eroded	923	0.3
1013	Pits, quarry	241	0.1
1027	Udorthents, wet	1,735	0.5
1029	Pits, gravel	1,565	0.4
1039	Urban land	1,811	0.5
1055	Aquolls and Histosols, ponded	1,550	0.4
1072	Udorthents, moderately shallow	389	0.1
1815	Zumbro loamy fine sand	1,104	0.3
1816	Kennebec Variant silt loam	989	0.3
1821	Algansee sandy loam, occasionally flooded	1,581	0.4
1824	Quam silt loam, ponded	980	0.3
1825C	Seelyeville muck, sloping	193	0.1
1827A	Waukegan silt loam, bedrock substratum, 0 to 2 percent slopes	1,246	0.3
1827B	Waukegan silt loam, bedrock substratum, 2 to 6 percent slopes	946	0.3

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
1827C	Waukegan silt loam, bedrock substratum, 6 to 12 percent slopes	271	0.1
1848B	Sparta loamy sand, bedrock substratum, 2 to 8 percent slopes	1,324	0.4
1894B	Winnebago loam, 2 to 6 percent slopes	873	0.2
1895B	Carmi loam, 2 to 8 percent slopes	3,354	0.9
1896B	Ostrander-Carmi loams, 2 to 6 percent slopes	2,626	0.7
1898F	Etter-Brodale complex, 25 to 60 percent slopes	1,555	0.4
1902B	Jewett silt loam, 1 to 6 percent slopes	1,187	0.3
	Total	368,640	100.0

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	Bromegrass-alfalfa	Kentucky bluegrass
	Bu	Bu	Bu	Ton	AUM*	AUM*
2B---------- Ostrander	125	39	85	5.0	9.0	7.2
2C---------- Ostrander	115	35	78	4.7	8.5	6.8
7A---------- Hubbard	55	18	50	2.0	4.0	3.3
7B---------- Hubbard	50	18	48	2.0	4.0	3.3
7C---------- Hubbard	---	---	---	1.7	3.5	2.7
7D---------- Hubbard	---	---	---	1.5	3.0	2.3
8A---------- Sparta	60	20	50	2.5	4.7	3.8
8B---------- Sparta	55	18	40	2.5	4.7	3.8
12C---------- Emmert	---	---	30	1.9	3.4	2.6
27A---------- Dickinson	90	32	68	3.5	6.6	5.2
27B---------- Dickinson	85	31	66	3.2	6.4	5.0
39A---------- Wadena	95	35	82	3.7	6.6	5.2
39B, 39B2---------- Wadena	90	34	80	3.6	6.5	5.0
39C, 39C2---------- Wadena	75	28	68	3.0	5.5	4.4
39D---------- Wadena	60	22	62	2.5	4.7	3.8
41A---------- Estherville	65	24	50	2.6	4.8	3.9
41B---------- Estherville	60	22	50	2.6	4.7	3.8
42C---------- Salida	---	---	---	---	---	1.5
49B---------- Antigo	100	35	80	4.0	7.6	6.0
81B---------- Boone	45	20	45	2.0	3.6	3.0
81C---------- Boone	40	18	40	2.0	3.4	2.8

See footnotes 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	Bromegrass-alfalfa	Kentucky bluegrass
	Bu	Bu	Bu	Ton	AUM*	AUM*
81E---- Boone	---	---	---	---	---	1.0
94C---- Terril	120	39	84	5.2	9.4	7.5
98---- Colo	100	34	72	4.3	7.8	6.3
100A---- Copaston	60	22	48	2.7	5.0	4.0
100B---- Copaston	55	22	48	2.7	5.0	4.0
100C---- Copaston	50	20	40	2.5	4.7	3.8
106B---- Lester	120	40	85	4.5	8.1	6.5
106C, 106C2---- Lester	100	35	75	3.8	6.8	5.4
106D2---- Lester	80	28	60	3.0	5.5	4.9
109---- Cordova	105	36	75	4.0	7.6	6.0
113---- Webster	120	42	88	4.4	8.0	6.3
114---- Glencoe	95	34	75	3.8	7.1	5.6
129---- Cylinder	95	33	70	3.7	7.1	5.6
150B---- Spencer	100	35	75	4.2	7.8	6.3
151C---- Burkhardt	55	---	50	2.7	5.0	4.0
151D---- Burkhardt	---	---	---	2.1	4.0	3.3
155B---- Chetek	60	---	60	3.0	5.2	4.3
155C---- Chetek	55	---	55	2.5	4.7	3.8
155E---- Chetek	---	---	---	---	---	0.8
173F---- Frontenac	---	---	---	---	---	1.5
176---- Garwin	130	42	88	4.6	8.0	6.4
177A, 177B, 177C---- Gotham	65	---	60	3.0	5.5	4.4
189---- Auburndale	90	36	70	3.5	6.6	5.2

See footnotes 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	Bromegrass-alfalfa	Kentucky bluegrass
	Bu	Bu	Bu	Ton	AUM*	AUM*
203B---------- Joy	130	42	88	5.2	9.4	7.5
208---------- Kato	100	40	80	4.0	7.6	6.0
213B---------- Klinger	115	42	84	4.5	8.1	6.5
226---------- Lawson	130	45	88	4.8	8.5	6.8
239---------- Le Sueur	120	38	80	5.0	9.0	7.2
250---------- Kennebec	130	38	75	4.8	8.6	6.8
251D---------- Marlean	---	---	---	1.8	3.6	2.3
251E---------- Marlean	---	---	---	---	---	1.1
252---------- Marshan	100	35	70	4.0	7.8	6.2
253---------- Maxcreek	120	38	80	4.5	8.2	6.6
255---------- Mayer	100	32	68	3.8	7.2	5.7
279B---------- Otterholt	110	36	85	4.0	7.6	6.0
279C---------- Otterholt	100	33	80	3.8	7.3	5.6
283A, 283B---------- Plainfield	50	22	45	2.5	4.7	3.8
283D---------- Plainfield	---	---	---	---	---	2.0
285A---------- Port Byron	135	45	88	5.5	9.8	7.8
285B---------- Port Byron	130	45	87	5.3	9.4	7.5
285C---------- Port Byron	110	38	78	4.8	8.5	6.8
299A---------- Rockton	95	32	74	3.6	7.1	5.6
299B---------- Rockton	90	30	70	3.6	6.7	5.3
299C---------- Rockton	75	28	68	3.4	6.5	4.9
301B---------- Lindstrom	130	42	87	5.5	9.9	7.9
313---------- Spillville	128	38	86	4.5	8.1	6.5

See footnotes 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	Bromegrass-alfalfa	Kentucky bluegrass
	Bu	Bu	Bu	Ton	AUM*	AUM*
317---- Oshawa	---	---	---	---	---	5.3
318---- Mayer	85	33	70	3.3	6.1	4.9
320B---- Tallula	130	42	86	4.8	8.5	6.8
320C2---- Tallula	118	34	78	4.4	8.0	6.5
342B---- Kingsley	85	32	72	3.2	6.0	4.8
342C---- Kingsley	75	28	64	3.0	5.5	4.4
342E---- Kingsley	---	---	---	2.2	4.4	3.6
342F---- Kingsley	---	---	---	---	---	2.0
344---- Quam	90	30	75	4.0	7.6	6.0
377B---- Merton	130	42	86	5.2	9.4	7.5
378---- Maxfield	125	39	82	4.5	8.3	6.5
382B---- Blooming	125	42	85	4.8	8.5	6.8
408---- Faxon	---	---	---	---	---	---
409B---- Etter	65	22	55	3.0	5.5	4.4
409C---- Etter	55	18	48	2.8	5.1	4.2
411A---- Waukegan	100	35	75	4.0	7.6	6.0
411B---- Waukegan	95	30	75	4.0	7.6	6.0
411C---- Waukegan	90	25	70	3.5	6.6	5.2
414---- Hamel	100	40	80	4.0	7.6	6.0
415A---- Kanaranzi	65	24	60	2.8	5.1	4.2
415B---- Kanaranzi	60	22	60	2.5	4.7	3.8
415C---- Kanaranzi	45	18	45	2.0	4.0	3.2
449B---- Crystal Lake	125	37	84	5.0	9.0	7.2

See footnotes 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	Bromegrass-alfalfa	Kentucky bluegrass
	Bu	Bu	Bu	Ton	AUM*	AUM*
454B, 454C---------- Mahtomedi	---	---	---	2.0	4.0	3.2
454E---------- Mahtomedi	---	---	---	---	---	1.0
463---------- Minneiska	110	32	80	3.8	7.2	5.6
465---------- Kalmarville	---	---	---	---	---	3.0
495---------- Zumbro	65	20	46	3.0	5.5	4.4
522---------- Boots	85	---	---	3.5	6.6	5.2
539---------- Palms	85	---	---	3.5	6.6	5.2
540---------- Seelyeville	85	---	---	3.5	6.6	5.2
545---------- Rondeau	85	---	---	3.3	6.2	4.8
611C---------- Hawick	45	18	37	1.7	3.6	2.8
611D---------- Hawick	---	---	---	---	---	1.0
611E, 611F---------- Hawick	---	---	---	---	---	0.6
857A---------- Urban land-Waukegan	---	---	---	---	---	---
857B---------- Urban land-Waukegan	---	---	---	---	---	---
858C---------- Urban land-Chetek	---	---	---	---	---	---
860C---------- Urban land-Lester	---	---	---	---	---	---
861C---------- Urban land-Kingsley	---	---	---	---	---	---
861E---------- Urban land-Kingsley	---	---	---	---	---	---
865B---------- Urban land-Hubbard	---	---	---	---	---	---
880F---------- Brodale-Rock outcrop	---	---	---	---	---	---
888B---------- Kingsley-Lester	95	31	68	3.7	7.1	5.6
888C---------- Kingsley-Lester	85	28	62	3.5	6.5	5.0
888D---------- Kingsley-Lester	75	25	56	3.1	5.5	4.5

See footnotes 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	Bromegrass-alfalfa	Kentucky bluegrass
	Bu	Bu	Bu	Ton	AUM*	AUM*
889B---- Wadena-Hawick	56	20	49	2.7	5.0	4.0
889C---- Wadena-Hawick	41	18	42	2.4	6.6	5.2
889D---- Wadena-Hawick	---	---	---	---	5.5	4.4
895B---- Kingsley-Mahtomedi-Spencer	51	---	57	2.7	5.0	4.0
895C---- Kingsley-Mahtomedi-Spencer	45	---	54	2.5	4.6	3.8
896E---- Kingsley-Mahtomedi	---	---	---	---	---	2.0
896F---- Kingsley-Mahtomedi	---	---	---	---	---	1.5
963C2---- Timula-Bold	85	32	72	3.3	6.0	4.8
963D2---- Timula-Bold	---	---	---	2.8	5.6	4.3
963E2---- Timula-Bold	---	---	---	---	---	---
1013**. Pits						
1027**. Udorthents						
1029**. Pits						
1039**. Urban land						
1055---- Aquolls and Histosols	---	---	---	---	---	---
1072**. Udorthents						
1815---- Zumbro	65	20	46	3.0	5.5	4.4
1816---- Kennebec	100	38	75	4.0	7.5	6.0
1821---- Algansee	80	26	65	3.5	6.6	5.2
1824---- Quam	---	---	---	---	---	---
1825C---- Seelyeville	---	---	---	---	---	---
1827A---- Waukegan	95	32	70	3.7	7.1	5.6

See footnotes 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	Bromegrass-alfalfa	Kentucky bluegrass
	Bu	Bu	Bu	Ton	AUM*	AUM*
1827B---------- Waukegan	90	28	70	3.7	7.1	5.6
1827C---------- Waukegan	85	24	65	3.2	6.0	4.8
1848B---------- Sparta	50	18	40	2.5	4.7	3.8
1894B---------- Winnebago	120	39	86	4.3	7.9	6.2
1895B---------- Carmi	95	32	73	3.6	6.5	5.2
1896B---------- Ostrander-Carmi	110	38	80	4.0	7.3	6.0
1898F---------- Etter-Brodale	---	---	---	---	---	1.4
1902B---------- Jewett	105	36	80	4.0	7.4	6.0

* 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.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	
7A, 7B, 7C--------- Hubbard	3s	Slight	Slight	Severe	Slight	Red pine---------- Eastern white pine-- Jack pine---------- Bur oak----------	56 54 58 40	Red pine, white spruce, eastern white pine, jack pine.
7D---------- Hubbard	4s	Moderate	Severe	Severe	Slight	Red pine---------- Eastern white pine-- Jack pine---------- Bur oak----------	49 47 52 40	Red pine, jack pine, eastern white pine.
8A, 8B---------- Sparta	3s	Slight	Slight	Severe	Slight	Jack pine---------- Northern red oak---- Red pine----------	57 47 ---	Red pine, eastern white pine, jack pine.
12C---------- Emmert	3s	Slight	Slight	Severe	Slight	Red pine---------- Eastern white pine-- Jack pine----------	56 54 60	Red pine, eastern white pine, jack pine.
49B---------- Antigo	2o	Slight	Slight	Slight	Slight	Sugar maple--------- American basswood--- Northern red oak---- Eastern white pine-- Yellow birch-------- White ash---------- Bigtooth aspen------	65 69 --- --- 71 74 ---	Eastern white pine, red pine, white spruce.
81B, 81C---------- Boone	4s	Slight	Slight	Severe	Slight	Northern pin oak---- Jack pine---------- Black oak----------	44 49 ---	Red pine, jack pine.
81E---------- Boone	4s	Moderate	Severe	Severe	Slight	Northern pin oak---- Jack pine---------- Black oak----------	44 49 ---	Red pine, jack pine.
106B, 106C, 106C2-- Lester	2o	Slight	Slight	Slight	Slight	Northern red oak---- American basswood--- Eastern cottonwood-- Eastern white pine-- White oak----------	69 69 92 64 62	Black walnut, northern red oak, American basswood, silver maple, white oak.
106D2---------- Lester	2r	Moderate	Moderate	Slight	Slight	Northern red oak---- American basswood--- Black walnut-------- Eastern cottonwood-- Eastern white pine-- White oak----------	69 69 62 92 64 62	Black walnut, northern red oak, American basswood, silver maple, white oak.
109---------- Cordova	3w	Slight	Moderate	Moderate	Slight	Eastern cottonwood-- American basswood--- Green ash---------- Sugar maple---------	90 60 52 55	Eastern cottonwood, black ash.
150B---------- Spencer	1o	Slight	Slight	Slight	Slight	Northern red oak---- Sugar maple--------- American basswood---	70 --- ---	Eastern white pine, red pine, white spruce, northern red oak.
151C---------- Burkhardt	3o	Slight	Slight	Slight	Slight	Northern pin oak---- Black oak---------- Jack pine----------	52 --- ---	Eastern white pine, red pine, jack pine.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	
151D---------- Burkhardt	3r	Moderate	Moderate	Slight	Slight	Northern pin oak----	52	Eastern white pine, red pine, jack pine.
						Black oak----------	---	
						Jack pine----------	---	
155B, 155C---------- Chetek	3s	Slight	Slight	Moderate	Slight	Northern pin oak----	53	Red pine, jack pine.
						Jack pine----------	57	
						Black oak----------	---	
						White oak----------	---	
155E---------- Chetek	3s	Moderate	Moderate	Moderate	Slight	Northern pin oak----	53	Red pine, jack pine.
						Jack pine----------	57	
						Black oak----------	---	
						White oak----------	---	
173F---------- Frontenac	3r	Severe	Severe	Severe	Slight	Northern red oak----	60	Eastern white pine, red pine, black walnut, northern red oak, American basswood.
						Quaking aspen-------	56	
						American basswood---	60	
						White oak----------	60	
177A, 177B, 177C--- Gotham	3s	Slight	Slight	Moderate	Slight	Northern pin oak----	54	Red pine, jack pine.
						Jack pine----------	60	
						Red pine----------	54	
						Eastern white pine--	56	
						Bur oak----------	40	
189---------- Auburndale	3w	Slight	Severe	Moderate	Moderate	Red maple----------	55	White spruce, black spruce.
						American basswood---	---	
						American elm--------	50	
						Black ash----------	45	
						Balsam poplar-------	70	
226---------- Lawson	4o	Slight	Slight	Slight	Slight	Silver maple--------	70	White spruce, silver maple, white ash.
						White ash----------	---	
						American elm--------	---	
239---------- Le Sueur	2o	Slight	Slight	Slight	Slight	Sugar maple---------	60	Eastern cottonwood, American basswood.
						American basswood---	70	
						Eastern cottonwood--	85	
250---------- Kennebec	2o	Slight	Slight	Slight	Slight	Bur oak----------	63	Black walnut, bur oak, hackberry, green ash, eastern cottonwood, American sycamore.
						Hackberry----------	---	
						Green ash----------	---	
						Eastern cottonwood--	---	
279B, 279C--------- Otterholt	1o	Slight	Slight	Slight	Slight	Northern red oak----	71	Eastern white pine, red pine, white spruce, northern red oak.
						Sugar maple---------	---	
						American basswood---	---	
283B---------- Plainfield	3s	Slight	Slight	Severe	Slight	Red pine----------	55	Red pine, eastern white pine, jack pine.
						Eastern white pine--	---	
						Jack pine----------	---	
						Northern pin oak----	---	
283D---------- Plainfield	3s	Moderate	Severe	Severe	Slight	Red pine----------	55	Red pine, eastern white pine, jack pine.
						Eastern white pine--	---	
						Jack pine----------	---	
						Northern pin oak----	---	
342B, 342C--------- Kingsley	2o	Slight	Slight	Slight	Slight	Red pine----------	60	Red pine, white spruce, jack pine.
						Eastern white pine--	57	
						Jack pine----------	62	
						Quaking aspen-------	75	

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	
342E, 342F--------- Kingsley	3r	Moderate	Moderate	Moderate	Slight	Red pine---------- Eastern white pine-- Jack pine---------- White spruce--------- Quaking aspen------- Northern red oak----	55 55 60 55 70 55	Red pine, northern red oak, white spruce, jack pine.
382B--------------- Blooming	2o	Slight	Slight	Slight	Slight	American basswood--- Eastern white pine-- Eastern cottonwood--	68 65 90	Black walnut, northern red oak, American basswood, silver maple, eastern white pine, white spruce.
414---------------- Hamel	3w	Slight	Moderate	Moderate	Slight	Eastern cottonwood-- American basswood--- Black ash----------	86 70 50	Eastern cottonwood, black ash, silver maple.
449B--------------- Crystal Lake	2o	Slight	Slight	Slight	Slight	Sugar maple--------- American basswood--- Yellow birch--------	59 69 ---	Eastern white pine, red pine, white spruce.
454B, 454C--------- Mahtomedi	3s	Slight	Slight	Severe	Slight	Red pine---------- Jack pine---------- Eastern white pine--	55 60 55	Red pine, white spruce, jack pine.
454E--------------- Mahtomedi	3s	Moderate	Moderate	Severe	Slight	Red pine---------- Jack pine---------- Eastern white pine--	55 60 55	Red pine, white spruce, jack pine.
463---------------- Minneiska	2o	Slight	Slight	Slight	Slight	Eastern cottonwood--	100	Black walnut, green ash, white oak, silver maple.
465---------------- Kalmarville	3w	Slight	Severe	Moderate	Moderate	Eastern cottonwood-- Silver maple-------- Green ash---------- American basswood---	90 60 60 80	Silver maple, eastern cottonwood, green ash, white spruce, American basswood.
858C*: Urban land.								
Chetek------------- Urban land.	3s	Slight	Slight	Moderate	Slight	Northern pin oak---- Jack pine---------- Black oak---------- White oak----------	53 57 --- ---	Red pine, jack pine.
860C*: Urban land.								
Lester------------- Urban land.	2o	Slight	Slight	Slight	Slight	Northern red oak---- American basswood--- Eastern cottonwood-- Eastern white pine-- White oak----------	69 69 92 64 62	Black walnut, northern red oak, American basswood, silver maple, white oak.
861C*: Urban land.								
Kingsley---------- Urban land.	2o	Slight	Slight	Slight	Slight	Red pine---------- Eastern white pine-- Jack pine---------- Quaking aspen-------	60 57 62 75	Red pine, white spruce, jack pine.

See footnote at end of table.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	
861E*:								
Urban land.								
Kingsley	3r	Moderate	Moderate	Moderate	Slight	Red pine	55	Red pine, northern red oak, white spruce, jack pine.
						Eastern white pine	55	
						Jack pine	60	
						Quaking aspen	70	
						Northern red oak	55	
865B*:								
Urban land.								
Hubbard	3s	Slight	Slight	Severe	Slight	Red pine	56	Red pine, white spruce, eastern white pine, jack pine.
						Eastern white pine	54	
						Jack pine	58	
						Bur oak	40	
						Shagbark hickory	40	
888B*, 888C*:								
Kingsley	2o	Slight	Slight	Slight	Slight	Red pine	60	Red pine, white spruce, jack pine.
						Eastern white pine	57	
						Jack pine	62	
						Quaking aspen	75	
Lester	2o	Slight	Slight	Slight	Slight	Northern red oak	69	Black walnut, northern red oak, American basswood, silver maple, white oak.
						American basswood	69	
						Eastern cottonwood	92	
						Eastern white pine	64	
						White oak	62	
888D*:								
Kingsley	3r	Moderate	Moderate	Moderate	Slight	Red pine	55	Red pine, northern red oak, white spruce, jack pine.
						Eastern white pine	55	
						Jack pine	60	
						Quaking aspen	70	
						Northern red oak	55	
Lester	2r	Moderate	Moderate	Slight	Slight	Northern red oak	69	Black walnut, northern red oak, American basswood, silver maple, white oak.
						American basswood	69	
						Eastern cottonwood	92	
						Eastern white pine	64	
						White oak	62	
895B*, 895C*:								
Kingsley	2o	Slight	Slight	Slight	Slight	Red pine	60	Red pine, white spruce, jack pine.
						Eastern white pine	57	
						Jack pine	62	
						Quaking aspen	75	
Mahtomedi	3s	Slight	Slight	Severe	Slight	Red pine	55	Red pine, white spruce, jack pine.
						Jack pine	60	
						Eastern white pine	55	
Spencer	1o	Slight	Slight	Slight	Slight	Northern red oak	71	Eastern white pine, red pine, white spruce.
						Sugar maple	---	
						American basswood	---	
896E*, 896F*:								
Kingsley	3r	Moderate	Moderate	Moderate	Slight	Red pine	55	Red pine, northern red oak, white spruce, jack pine.
						Eastern white pine	55	
						Jack pine	60	
						Quaking aspen	70	
						Northern red oak	55	

See footnote at end of table.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	
896E*, 896F*:								
Mahtomedi	3s	Moderate	Moderate	Severe	Slight	Red pine	55	Red pine, white spruce, jack pine.
						Jack pine	60	
						Eastern white pine	55	
963C2*:								
Timula	2o	Slight	Slight	Slight	Slight	White oak	70	Eastern white pine, red pine, Scotch pine.
						Northern red oak	---	
						Green ash	---	
						Bur oak	---	
Bold.								
963D2*, 963E2*:								
Timula	2r	Moderate	Moderate	Moderate	Slight	White oak	70	Eastern white pine, red pine.
						Northern red oak	---	
						Green ash	---	
						Bur oak	---	
Bold.								
1821 Algansee	3s	Slight	Slight	Moderate	Slight	Quaking aspen	60	White spruce, Carolina poplar, eastern white pine.
						Silver maple	78	
						White ash	---	
						Red maple	56	
1848B Sparta	3s	Slight	Slight	Moderate	Slight	Red pine	55	Red pine, eastern white pine, jack pine.
						Eastern white pine	---	
						Jack pine	---	
						Northern pin oak	---	
1902B Jewett	2o	Slight	Slight	Slight	Slight	Sugar maple	61	Eastern white pine, red pine.
						Northern red oak	---	
						American basswood	---	
						White ash	---	

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--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 heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
2B, 2C---------- Ostrander	---	Gray dogwood, Tatarian honeysuckle, lilac.	Siberian crabapple, Amur maple, eastern redcedar, northern white-cedar.	Eastern white pine, green ash, hackberry, red pine, Norway spruce.	---
7A, 7B, 7C-------- Hubbard	---	Eastern redcedar, Siberian crabapple, silver buffaloberry, Russian-olive, Tatarian honeysuckle, Siberian peashrub.	Hackberry, bur oak, jack pine, green ash, red pine, eastern white pine.	---	---
7D. Hubbard					
8A, 8B---------- Sparta	---	Eastern redcedar, Siberian peashrub, lilac, Siberian crabapple, Russian-olive, Tatarian honeysuckle.	Red pine, jack pine, Austrian pine, green ash.	White pine--------	---
12C---------- Emmert	---	Eastern redcedar, Siberian crabapple, Russian-olive, Tatarian honeysuckle, Siberian peashrub.	Hackberry, bur oak, jack pine, green ash, eastern white pine, red pine, Austrian pine.	---	---
27A, 27B---------- Dickinson	---	Siberian peashrub, Tatarian honeysuckle, lilac.	Eastern redcedar, hackberry, northern white-cedar, bur oak, white spruce, Scotch pine, Siberian crabapple.	Green ash---------	---
39A, 39B, 39B2, 39C, 39C2, 39D--- Wadena	---	Siberian peashrub, Siberian crabapple, lilac, Tatarian honeysuckle.	Eastern redcedar, Amur maple, northern white-cedar, white spruce.	Scotch pine, green ash, eastern white pine, red pine.	---
41A, 41B---------- Estherville	---	Eastern redcedar, Russian-olive, Siberian crabapple, silver buffaloberry, Tatarian honeysuckle, Siberian peashrub.	Red pine, jack pine, Austrian pine, hackberry, bur oak, eastern white pine.	---	---

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
42C---------- Salida	Lilac----------	Eastern redcedar, northern white-cedar, bur oak, Russian-olive, Tatarian honeysuckle, Siberian peashrub.	Hackberry, green ash, honeylocust.	Siberian elm------	---
49B---------- Antigo	Siberian peashrub	Eastern redcedar, radiant crabapple, Washington hawthorn, autumn-olive, Amur honeysuckle, lilac, Tatarian honeysuckle.	Eastern white pine, Austrian pine, red pine, jack pine.	---	---
81B, 81C, 81E----- Boone	Golden currant----	Peking cotoneaster, Tatarian honeysuckle, Siberian crabapple, eastern redcedar, silver buffaloberry, Russian-olive.	Eastern white pine, hackberry, white spruce, bur oak, green ash.	---	---
94C---------- Terril	---	Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, Siberian crabapple, Amur maple.	Hackberry, bur oak, eastern white pine, red pine, green ash.	Silver maple.
98---------- Colo	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Norway spruce, Austrian pine, blue spruce, northern white-cedar, Washington hawthorn.	Eastern white pine.	Northern pin oak.
100A, 100B, 100C-- Copaston	---	Eastern redcedar, Siberian crabapple, silver buffaloberry, Tatarian honeysuckle, Russian-olive, Siberian peashrub.	Red pine.	---	---
106B, 106C, 106C2- Lester	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, Siberian crabapple, Amur maple, white spruce.	Eastern white pine, green ash, hackberry, Scotch pine.	Silver maple.
106D2. Lester					
109---------- Cordova	---	Tatarian honeysuckle, American plum, purpleosier willow, redosier dogwood.	Northern white-cedar, white spruce, Amur maple.	Green ash, golden willow, hackberry.	Eastern cottonwood, silver maple.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
113---------- Webster	---	Northern white-cedar, redosier dogwood, purpleosier willow, Tatarian honeysuckle.	Siberian crabapple, Amur maple, green ash, eastern white pine, white spruce.	Silver maple, golden willow.	Eastern cottonwood.
114---------- Glencoe	---	Redosier dogwood, medium purple willow, northern white-cedar, Tatarian honeysuckle.	Siberian crabapple, eastern white pine, Amur maple, white spruce.	Green ash, silver maple, golden willow.	Eastern cottonwood.
129---------- Cylinder	---	Siberian crabapple, Tatarian honeysuckle, Siberian peashrub, lilac.	Eastern redcedar, hackberry, northern white-cedar, bur oak, white spruce, Scotch pine.	Green ash---------	---
150B---------- Spencer	---	Lilac, Tatarian honeysuckle.	White spruce, Amur maple, northern white-cedar, Siberian crabapple.	Green ash, bur oak, eastern white pine, red pine, hackberry.	Silver maple.
151C, 151D-------- Burkhardt	Golden currant----	Eastern redcedar, Russian-olive, silver buffaloberry, Siberian crabapple, Tatarian honeysuckle, Peking cotoneaster.	Hackberry, white spruce, bur oak, eastern white pine, green ash.	---	---
155B, 155C, 155E-- Chetek	Golden currant----	Eastern redcedar, Russian-olive, silver buffaloberry, Siberian crabapple, Tatarian honeysuckle, Peking cotoneaster.	Hackberry, white spruce, bur oak, eastern white pine, green ash.	---	---
173F. Frontenac					
176---------- Garwin	---	Northern white-cedar, redosier dogwood, purpleosier willow, Tatarian honeysuckle.	Siberian crabapple, Amur maple, eastern white pine, white spruce.	Silver maple, golden willow, green ash.	Eastern cottonwood.
177A, 177B, 177C-- Gotham	---	Eastern redcedar, lilac, Siberian peashrub, Tatarian honeysuckle.	Austrian pine, red pine, jack pine.	Eastern white pine.	---
189. Auburndale					

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
203B---------- Joy	---	Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, Siberian crabapple, Amur maple.	Hackberry, bur oak, eastern white pine, red pine, green ash.	Silver maple.
208---------- Kato	---	Tall purple willow, American plum, northern white-cedar, redosier dogwood, Tatarian honeysuckle.	Amur maple, blue spruce.	Golden willow, hackberry, green ash.	Eastern cottonwood, silver maple.
213B---------- Klinger	---	Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, Siberian crabapple, Amur maple.	Hackberry, bur oak, eastern white pine, red pine, green ash.	Silver maple.
226---------- Lawson	Redosier dogwood, gray dogwood.	Northern white-cedar, redosier dogwood, nannyberry viburnum, autumn-olive, silky dogwood.	Jack pine, white ash, white spruce.	Eastern white pine, silver maple.	---
239---------- Le Sueur	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, Siberian crabapple, Amur maple.	Scotch pine, eastern white pine, green ash, hackberry.	Silver maple.
250---------- Kennebec	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Northern white-cedar, Austrian pine, blue spruce, Washington hawthorn.	Norway spruce-----	Northern pin oak, eastern white pine.
251D---------- Marlean	---	Eastern redcedar, Tatarian honeysuckle, lilac, Siberian peashrub, American plum.	Russian-olive, eastern white pine, red pine, Norway spruce, honeylocust, green ash, hackberry.	---	---
251E. Marlean					
252---------- Marshan	---	Redosier dogwood, northern white-cedar, American plum, purpleosier willow, Tatarian honeysuckle.	Amur maple, white spruce.	Hackberry, golden willow, silver maple, green ash.	Eastern cottonwood.
253---------- Maxcreek	---	Purpleosier willow, Tatarian honeysuckle, northern white-cedar, American plum, redosier dogwood.	White spruce, Amur maple.	Hackberry, golden willow, green ash.	Eastern cottonwood, silver maple.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
255---------- Mayer	---	Medium purple willow, Tatarian honeysuckle, redosier dogwood, Siberian peashrub, American plum.	Russian-olive, white spruce, eastern redcedar.	Green ash---------	Siberian elm, golden willow, eastern cottonwood.
279B, 279C-------- Otterholt	---	Tatarian honeysuckle, lilac.	Northern white-cedar, Siberian crabapple, white spruce, Amur maple.	Red pine, bur oak, eastern white pine, green ash, hackberry.	Silver maple.
283A, 283B, 283D-- Plainfield	---	Siberian peashrub, lilac, eastern redcedar, Tatarian honeysuckle, silver buffaloberry.	Eastern white pine, red pine, jack pine, hackberry, Austrian pine.	---	---
285A, 285B, 285C-- Port Byron	---	White spruce, Tatarian honeysuckle, lilac.	Northern white-cedar, Siberian crabapple, Amur maple.	Hackberry, bur oak, eastern white pine, red pine, green ash.	Silver maple.
299A, 299B, 299C-- Rockton	---	Siberian peashrub, Siberian crabapple, Tatarian honeysuckle, lilac.	Eastern redcedar, northern white-cedar, Amur maple, white spruce.	Eastern white pine, green ash, Scotch pine, Austrian pine.	---
301B---------- Lindstrom	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, Siberian crabapple, Amur maple.	Scotch pine, eastern white pine, green ash, hackberry.	Silver maple.
313---------- Spillville 317. Oshawa	---	Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, Siberian crabapple, Amur maple.	Hackberry, bur oak, eastern white pine, red pine, green ash.	Silver maple.
318---------- Mayer	---	Medium purple willow, Tatarian honeysuckle, redosier dogwood, Siberian peashrub, American plum.	Russian-olive, white spruce, eastern redcedar.	Green ash---------	Golden willow, eastern cottonwood, Siberian elm.
320B, 320C2------- Tallula	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	White spruce, blue spruce, northern white-cedar, Washington hawthorn.	Norway spruce, Austrian pine, green ash.	Eastern white pine.
342B, 342C-------- Kingsley	---	Siberian peashrub, Siberian crabapple, lilac, Tatarian honeysuckle.	Eastern redcedar, Amur maple, northern white-cedar, white spruce.	Scotch pine, green ash, eastern white pine.	Silver maple.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
342E, 342F. Kingsley					
344---------- Quam	Lilac, silky dogwood.	Siberian peashrub, Tatarian honeysuckle.	Hackberry, blue spruce, Siberian crabapple, eastern redcedar, Norway spruce.	Golden willow, green ash.	Eastern cottonwood.
377B---------- Merton	---	Tatarian honeysuckle, lilac, redosier dogwood.	Northern white-cedar, white spruce, Siberian crabapple, Amur maple.	Eastern white pine, green ash, hackberry, Scotch pine.	Silver maple.
378---------- Maxfield	---	Northern white-cedar, redosier dogwood, medium purple willow, Tatarian honeysuckle.	Siberian crabapple, Amur maple, eastern white pine, white spruce.	Silver maple, golden willow, green ash.	Eastern cottonwood.
382B---------- Blooming	---	Lilac, Tatarian honeysuckle, redosier dogwood.	White spruce, northern white-cedar, Amur maple, Siberian crabapple.	Eastern white pine, Scotch pine, green ash, hackberry.	Silver maple.
408. Faxon					
409B, 409C-------- Etter	---	Siberian crabapple, Siberian peashrub, lilac, Amur maple, Tatarian honeysuckle.	Northern white-cedar, white spruce, eastern redcedar.	Eastern white pine, green ash, Scotch pine.	Silver maple.
411A, 411B, 411C-- Waukegan	---	Siberian peashrub, Siberian crabapple, lilac, Tatarian honeysuckle.	Eastern redcedar, Amur maple, northern white-cedar, white spruce.	Scotch pine, green ash, eastern white pine.	Silver maple.
414---------- Hamel	---	Northern white-cedar, purpleosier willow, Tatarian honeysuckle, American plum, redosier dogwood.	White spruce, Amur maple.	Hackberry, golden willow, green ash.	Eastern cottonwood, silver maple.
415A, 415B, 415C-- Kanaranzi	Lilac----------	Eastern redcedar, northern white-cedar, Russian-olive, Tatarian honeysuckle, bur oak, Siberian crabapple.	Jack pine, green ash, white spruce, red pine, eastern white pine.	---	---
449B---------- Crystal Lake	---	Northern white-cedar, lilac, American cranberrybush, Amur maple, silky dogwood, gray dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine, white ash, red maple.	---

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
454B, 454C--------- Mahtomedi 454E. Mahtomedi	Lilac----------	Eastern redcedar, Russian-olive, Siberian crabapple, northern white-cedar.	Eastern white pine, red pine, hackberry, bur oak, white spruce, Scotch pine, jack pine.	---	---
463---------- Minneiska	---	Tatarian honeysuckle, Siberian peashrub, lilac.	Northern white-cedar, purpleosier willow, white spruce, blue spruce, Siberian crabapple.	Hackberry, golden willow, green ash.	Eastern cottonwood.
465---------- Kalmarville	---	Purpleosier willow, Tatarian honeysuckle, northern white-cedar, American plum, redosier dogwood.	White spruce, blue spruce.	Hackberry, golden willow, green ash.	Eastern cottonwood, Carolina poplar.
495---------- Zumbro	Golden currant----	Eastern redcedar, Russian-olive, silver buffaloberry, Siberian crabapple, Tatarian honeysuckle, Peking cotoneaster.	Hackberry, white spruce, bur oak, eastern white pine, green ash.	---	---
522---------- Boots	---	Northern white-cedar, redosier dogwood, medium purple willow, Tatarian honeysuckle.	Siberian crabapple, white spruce, blue spruce.	Golden willow, green ash.	Eastern cottonwood, Carolina poplar.
539---------- Palms	Common ninebark, white belle honeysuckle.	Silky dogwood, Tatarian honeysuckle, Amur privet.	Tall purple willow.	Golden willow, black willow, white willow.	Carolina poplar, eastern cottonwood.
540---------- Seelyeville	White belle honeysuckle.	Common ninebark, silky dogwood, medium purple willow, Amur privet.	Tall purple willow.	Golden willow, white willow, black willow.	Eastern cottonwood, Carolina poplar.
545---------- Rondeau	Common ninebark, white belle honeysuckle.	Amur privet, Tatarian honeysuckle, silky dogwood.	Tall purple willow.	Golden willow, black willow, white willow.	Eastern cottonwood, Carolina poplar.
511C---------- Hawick	---	Northern white-cedar Russian-olive, Siberian crabapple, eastern redcedar, Siberian peashrub, Tatarian honeysuckle, bur oak.	Jack pine, hackberry, red pine, eastern white pine.	---	---

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year acreage heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
611D, 611E, 611F. Hawick					
857A*, 857B*: Urban land.					
Waukegan	---	Siberian peashrub, Siberian crabapple, lilac, Tatarian honeysuckle.	Eastern redcedar, Amur maple, northern white-cedar, white spruce.	Scotch pine, green ash, eastern white pine.	Silver maple.
858C*: Urban land.					
Chetek	Golden currant	Eastern redcedar, Russian-olive, silver buffaloberry, Siberian crabapple, Tatarian honeysuckle, Peking cotoneaster.	Hackberry, white spruce, bur oak, eastern white pine, green ash.	---	---
860C*: Urban land.					
Lester	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, Siberian crabapple, Amur maple, white spruce.	Eastern white pine, green ash, hackberry, Scotch pine.	Silver maple.
861C*: Urban land.					
Kingsley	---	Siberian peashrub, Siberian crabapple, lilac, Tatarian honeysuckle.	Eastern redcedar, Amur maple, northern white-cedar, white spruce.	Scotch pine, green ash, eastern white pine.	Silver maple.
861E*: Urban land.					
Kingsley.					
865B*: Urban land.					
Hubbard	---	Eastern redcedar, Siberian crabapple, silver buffalo-berry, Russian-olive, Tatarian honeysuckle, Siberian peashrub.	Hackberry, bur oak, jack pine, green ash, red pine, eastern white pine.	---	---
880F*: Brodale.					
Rock outcrop.					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
888B*, 888C*:					
Kingsley	---	Siberian peashrub, Siberian crabapple, lilac, Tatarian honeysuckle.	Eastern redcedar, Amur maple, northern white-cedar, white spruce.	Scotch pine, green ash, eastern white pine.	Silver maple.
Lester	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, Siberian crabapple, Amur maple, white spruce.	Eastern white pine, green ash, hackberry, Scotch pine.	Silver maple.
888D*:					
Kingsley.					
Lester.					
889B*, 889C*:					
Wadena	---	Siberian peashrub, Siberian crabapple, lilac, Tatarian honeysuckle.	Eastern redcedar, Amur maple, northern white-cedar, white spruce.	Scotch pine, green ash, eastern white pine, red pine.	---
Hawick	---	Northern white-cedar, Russian-olive, Siberian crabapple, eastern redcedar, Siberian peashrub, Tatarian honeysuckle, bur oak.	Jack pine, hackberry, red pine, eastern white pine.	---	---
889D*:					
Wadena	---	Siberian peashrub, Siberian crabapple, lilac, Tatarian honeysuckle.	Eastern redcedar, Amur maple, northern white-cedar, white spruce.	Scotch pine, green ash, eastern white pine, red pine.	---
Hawick.					
895B*, 895C*:					
Kingsley	---	Siberian peashrub, Siberian crabapple, lilac, Tatarian honeysuckle.	Eastern redcedar, Amur maple, northern white-cedar, white spruce.	Scotch pine, green ash, eastern white pine.	Silver maple.
Mahtomedi	Lilac	Eastern redcedar, Russian-olive, Siberian crabapple, northern white-cedar.	Eastern white pine, red pine, hackberry, bur oak, white spruce, Scotch pine, jack pine.	---	---
Spencer	---	Lilac, Tatarian honeysuckle.	White spruce, Amur maple, northern white-cedar, Siberian crabapple.	Green ash, bur oak, eastern white pine, red pine. hackberry.	Silver maple.
896E*, 896F*:					
Kingsley.					
Mahtomedi.					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
963C2*: Timula	---	Siberian peashrub, Tatarian honeysuckle, lilac, American plum.	Bur oak, hackberry, green ash, northern white-cedar, Russian-olive, eastern redcedar.	Honeylocust, Siberian elm.	---
Bold	---	Northern white-cedar, lilac, Siberian peashrub, Tatarian honeysuckle.	White spruce, Siberian crabapple, eastern redcedar.	Green ash, Russian-olive.	Siberian elm.
963D2*, 963E2*: Timula	---	Siberian peashrub, Tatarian honeysuckle, lilac, American plum.	Bur oak, hackberry, northern white-cedar, green ash, Russian-olive, eastern redcedar.	Honeylocust, Siberian elm.	---
Bold.					
1013*. Pits					
1027*. Udorthents					
1029*. Pits					
1039*. Urban land					
1055*: Aquolls.					
Histosols.					
1072*. Udorthents					
1815--- Zumbro	Golden currant---	Eastern redcedar, Russian-olive, silver buffaloberry, Siberian crabapple, Tatarian honeysuckle, Peking cotoneaster.	Hackberry, white spruce, bur oak, eastern white pine, green ash.	---	---
1816--- Kennebec Variant	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Northern white-cedar, Austrian pine, blue spruce, Washington hawthorn.	Norway spruce-----	Northern pin oak, eastern white pine.
1821--- Algansee	Vanhoutte spirea	White spruce, Amur privet, Tatarian honeysuckle, American cranberrybush.	Northern white-cedar, Manchurian crabapple.	Green ash, eastern white pine, Norway spruce, golden willow.	Carolina poplar.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
1824. Quam					
1825C. Seelyeville					
1827A, 1827B, 1827C---------- Waukegan	---	Siberian crabapple, Amur honeysuckle, lilac, Tatarian honeysuckle.	Eastern redcedar, northern white-cedar, Norway spruce, Scotch pine, hackberry, bur oak, white spruce.	Green ash---------	---
1848B---------- Sparta	Golden currant----	Siberian peashrub, Russian-olive, eastern redcedar, lilac, Siberian crabapple, Tatarian honey-suckle.	Green ash, red pine, jack pine, Austrian pine.	Eastern white pine.	---
1894B---------- Winnebago	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Blue spruce, northern white-cedar, Washington hawthorn.	Norway spruce, Austrian pine.	Eastern white pine, northern pin oak.
1895B---------- Carmi	Siberian peashrub	Eastern redcedar, radiant crab-apple, Washington hawthorn, autumn-olive, Amur honeysuckle, lilac, Tatarian honeysuckle.	Eastern white pine, Austrian pine, red pine, jack pine.	---	---
1896B*: Ostrander--------	---	Gray dogwood, Tatarian honeysuckle, lilac.	Siberian crabapple, Amur maple, eastern redcedar, northern white-cedar.	Eastern white pine, green ash, hackberry, red pine, Norway spruce.	---
Carmi----------	Siberian peashrub	Eastern redcedar, radiant crab-apple, Washington hawthorn, autumn-olive, Amur honeysuckle, lilac, Tatarian honeysuckle.	Eastern white pine, Austrian pine, red pine, jack pine.	---	---
1898F*: Etter----------	---	Siberian crab-apple, Siberian peashrub, lilac Amur maple, Tatarian honeysuckle.	Northern white-cedar, white spruce, eastern redcedar.	Eastern white pine, green ash, Scotch pine.	Silver maple.
Brodale.					
1902B---------- Jewett	---	Common ninebark, northern white-cedar, silky dogwood, lilac.	White spruce, Norway spruce, Amur maple.	Eastern white pine, red pine, green ash, jack pine.	Silver maple.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--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
2B Ostrander	Slight	Slight	Moderate: slope.	Slight	Slight.
2C Ostrander	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
7A Hubbard	Slight	Slight	Slight	Slight	Severe: droughty.
7B Hubbard	Slight	Slight	Moderate: slope.	Slight	Severe: droughty.
7C Hubbard	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Severe: droughty.
7D Hubbard	Severe: slope.	Severe: slope.	Severe: slope.	Slight	Severe: droughty, slope.
8A Sparta	Slight	Slight	Moderate: small stones.	Slight	Moderate: droughty.
8B Sparta	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
12C Emmert	Moderate: small stones, slope.	Moderate: small stones, slope.	Severe: slope, small stones.	Slight	Severe: droughty.
27A Dickinson	Slight	Slight	Slight	Slight	Slight.
27B Dickinson	Slight	Slight	Moderate: slope.	Slight	Slight.
39A Wadena	Slight	Slight	Moderate: small stones.	Slight	Slight.
39B, 39B2 Wadena	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
39C, 39C2 Wadena	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
39D Wadena	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
41A Estherville	Slight	Slight	Moderate: small stones.	Slight	Moderate: droughty.
41B Estherville	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
42C Salida	Moderate: slope, small stones.	Moderate: slope, small stones.	Severe: slope, small stones.	Slight	Severe: droughty.
49B Antigo	Slight	Slight	Moderate: slope.	Slight	Slight.
81B Boone	Slight	Slight	Moderate: slope, depth to rock.	Slight	Moderate: droughty, thin layer.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
81C---------- Boone	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: droughty, slope, thin layer.
81E---------- Boone	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
94C---------- Terril	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
98---------- Colo	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
100A, 100B---------- Copaston	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight----------	Severe: thin layer.
100C---------- Copaston	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight----------	Severe: thin layer.
106B---------- Lester	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
106C, 106C2---------- Lester	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
106D2---------- Lester	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
109---------- Cordova	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
113---------- Webster	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
114---------- Glencoe	Severe: ponding, flooding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
129---------- Cylinder	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight----------	Slight.
150B---------- Spencer	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
151C---------- Burkhardt	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: droughty, slope.
151D---------- Burkhardt	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
155B---------- Chetek	Slight----------	Slight----------	Moderate: slope, small stones.	Slight----------	Moderate: large stones, droughty.
155C---------- Chetek	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: large stones, slope, droughty.
155E---------- Chetek	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
173F---------- Frontenac	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
176--Garwin	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
177A--Gotham	Slight	Slight	Slight	Slight	Moderate: droughty.
177B--Gotham	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
177C--Gotham	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
189--Auburndale	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
203B--Joy	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight	Slight.
208--Kato	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
213B--Klinger	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight	Slight.
226--Lawson	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
239--Le Sueur	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight	Slight.
250--Kennebec	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
251D, 251E--Marlean	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Moderate: slope.	Severe: slope.
252--Marshan	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness.
253--Maxcreek	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
255--Mayer	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
279B--Otterholt	Slight	Slight	Moderate: slope.	Slight	Slight.
279C--Otterholt	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.	Moderate: slope.
283A--Plainfield	Slight	Slight	Slight	Slight	Moderate: droughty.
283B--Plainfield	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
283D--Plainfield	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope, droughty.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
285A Port Byron	Slight	Slight	Slight	Slight	Slight.
285B Port Byron	Slight	Slight	Moderate: slope.	Slight	Slight.
285C Port Byron	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
299A Rockton	Slight	Slight	Slight	Slight	Moderate: thin layer.
299B Rockton	Slight	Slight	Moderate: slope, depth to rock.	Slight	Moderate: thin layer.
299C Rockton	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope, thin layer.
301B Lindstrom	Slight	Slight	Moderate: slope.	Slight	Slight.
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.
318 Mayer	Severe: flooding, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
320B Tallula	Slight	Slight	Moderate: slope.	Slight	Slight.
320C2 Tallula	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
342B Kingsley	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, small stones, percs slowly.	Slight	Slight.
342C Kingsley	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
342E Kingsley	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
342F Kingsley	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
344 Quam	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
377B Merton	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight	Slight.
378 Maxfield	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
382B Blooming	Slight	Slight	Moderate: slope.	Slight	Slight.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
408--Faxon	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.
409B--Etter	Slight	Slight	Moderate: slope.	Slight	Slight.
409C--Etter	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
411A--Waukegan	Slight	Slight	Slight	Slight	Slight.
411B--Waukegan	Slight	Slight	Moderate: slope.	Slight	Slight.
411C--Waukegan	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
414--Hamel	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
415A--Kanaranzi	Slight	Slight	Slight	Slight	Slight.
415B--Kanaranzi	Slight	Slight	Moderate: slope.	Slight	Slight.
415C--Kanaranzi	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
449B--Crystal Lake	Slight	Slight	Moderate: slope.	Slight	Slight.
454B--Mahtomedi	Moderate: small stones.	Moderate: small stones.	Severe: small stones.	Slight	Moderate: small stones, droughty.
454C--Mahtomedi	Moderate: slope, small stones.	Moderate: slope, small stones.	Severe: slope, small stones.	Slight	Moderate: small stones, droughty, slope.
454E--Mahtomedi	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Slight	Severe: slope.
463--Minneiska	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
465--Kalmarville	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.
495--Zumbro	Severe: flooding.	Slight	Slight	Slight	Slight.
522--Boots	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding, flooding.	Severe: ponding, excess humus.	Severe: ponding, flooding, excess humus.
539--Palms	Severe: ponding, excess humus, flooding.	Severe: ponding, excess humus.	Severe: ponding, excess humus, flooding.	Severe: ponding, excess humus.	Severe: ponding, excess humus, flooding.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
540 Seelyeville	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding, flooding.	Severe: ponding, excess humus.	Severe: ponding, flooding, excess humus.
545 Rondeau	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding, flooding.	Severe: ponding, excess humus.	Severe: ponding, flooding, excess humus.
611C Hawick	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Severe: droughty.
611D, 611E Hawick	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: droughty, slope.
611F Hawick	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
857A*: Urban land.					
Waukegan	Slight	Slight	Slight	Slight	Slight.
857B*: Urban land.					
Waukegan	Slight	Slight	Moderate: slope.	Slight	Slight.
858C*: Urban land.					
Chetek	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: large stones, slope, droughty.
860C*: Urban land.					
Lester	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
861C*: Urban land.					
Kingsley	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
861E*: Urban land.					
Kingsley	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
865B*: Urban land.					
Hubbard	Slight	Slight	Moderate: slope.	Slight	Severe: droughty.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
880F*:					
Brodale	Severe: slope, small stones.	Severe: slope, small stones.	Severe: large stones, slope, small stones.	Severe: slope, small stones.	Severe: small stones, droughty, slope.
Rock outcrop.					
888B*:					
Kingsley	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, small stones, percs slowly.	Slight	Slight.
Lester	Slight	Slight	Moderate: slope.	Slight	Slight.
888C*:					
Kingsley	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
Lester	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
888D*:					
Kingsley	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Lester	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
889B*:					
Wadena	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
Hawick	Slight	Slight	Moderate: slope, small stones.	Slight	Severe: droughty.
889C*:					
Wadena	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Hawick	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Severe: droughty.
889D*:					
Wadena	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Hawick	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: droughty, slope.
895B*:					
Kingsley	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, small stones, percs slowly.	Slight	Slight.
Mahtomedi	Moderate: small stones.	Moderate: small stones.	Severe: small stones.	Slight	Moderate: small stones, droughty.
Spencer	Slight	Slight	Moderate: slope.	Slight	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
895C*:					
Kingsley	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
Mahtomedi	Moderate: slope, small stones.	Moderate: slope, small stones.	Severe: slope, small stones.	Slight	Moderate: small stones, droughty, slope.
Spencer	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.	Moderate: slope.
896E*:					
Kingsley	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Mahtomedi	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Slight	Severe: slope.
896F*:					
Kingsley	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Mahtomedi	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Slight	Severe: slope.
963C2*:					
Timula	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.	Moderate: slope.
Bold	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.	Moderate: slope.
963D2*, 963E2*:					
Timula	Severe: slope.	Severe: slope.	Severe: slope.	Severe: erodes easily.	Severe: slope.
Bold	Severe: slope.	Severe: slope.	Severe: slope.	Severe: erodes easily.	Severe: slope.
1013*. Pits					
1027*. Udorthents					
1029*. Pits					
1039*. Urban land					
1055*: Aquolls.					
Histosols.					
1072*. Udorthents					
1815 Zumbro	Slight	Slight	Slight	Slight	Slight.
1816 Kennebec Variant	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
1821--Algansee	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: flooding, wetness.
1824--Quam	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
1825C--Seelyeville	Severe: wetness, excess humus.	Severe: wetness, excess humus.	Severe: slope, excess humus, wetness.	Severe: wetness, excess humus.	Severe: wetness, excess humus.
1827A--Waukegan	Slight	Slight	Slight	Slight	Moderate: thin layer.
1827B--Waukegan	Slight	Slight	Moderate: slope, depth to rock.	Slight	Moderate: thin layer.
1827C--Waukegan	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope, thin layer.
1848B--Sparta	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
1894B--Winnebago	Slight	Slight	Moderate: slope.	Slight	Slight.
1895B--Carmi	Slight	Slight	Moderate: slope.	Slight	Slight.
1896B*:					
Ostrander	Slight	Slight	Moderate: slope.	Slight	Slight.
Carmi	Slight	Slight	Moderate: slope.	Slight	Slight.
1898F*:					
Etter	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Brodale	Severe: slope, small stones.	Severe: slope, small stones.	Severe: large stones, slope, small stones.	Severe: slope, s*all stones.	Severe: small stones, droughty, slope.
1902B--Jewett	Slight	Slight	Moderate: slope.	Slight	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--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
2B---------- Ostrander	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
2C---------- Ostrander	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
7A, 7B, 7C---------- Hubbard	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
7D---------- Hubbard	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.
8A, 8B---------- Sparta	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
12C---------- Emmert	Poor	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
27A, 27B---------- Dickinson	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
39A, 39B, 39B2----- Wadena	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
39C, 39C2---------- Wadena	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
39D. Wadena										
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.
49B---------- Antigo	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
81B, 81C---------- Boone	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
81E---------- Boone	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
94C---------- Terril	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
98---------- Colo	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
100A, 100B, 100C--- Copaston	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
106B---------- Lester	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
106C, 106C2, 106D2- Lester	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
109---------- Cordova	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.

TABLE 9.--WILDLIFE HABITAT--Continued

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
113--Webster	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
114--Glencoe	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
129--Cylinder	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
150B--Spencer	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
151C--Burkhardt	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
151D--Burkhardt	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
155B, 155C--Chetek	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
155E--Chetek	Very poor.	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
173F--Frontenac	Very poor.	Very poor.	Poor	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
176--Garwin	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
177A, 177B, 177C--Gotham	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
189--Auburndale	Good	Good	Fair	Fair	Good	Good	Good	Good	Fair	Good.
203B--Joy	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
208--Kato	Good	Fair	Fair	Poor	Poor	Good	Good	Good	Poor	Good.
213B--Klinger	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
226--Lawson	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
239--Le Sueur	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
250--Kennebec	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
251D, 251E--Marlean	Very poor.	Very poor.	Fair	Fair	Fair	Very poor.	Very poor.	Very poor.	Poor	Very poor.
252--Marshan	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
253--Maxcreek	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
255--Mayer	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
279B--Otterholt	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.

TABLE 9.--WILDLIFE HABITAT--Continued

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
279C---------- Otterholt	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
283A, 283B---------- Plainfield	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
283D---------- Plainfield	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
285A, 285B---------- Port Byron	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
285C---------- Port Byron	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
299A, 299B, 299C--- Rockton	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
301B---------- Lindstrom	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
313---------- Spillville	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
317---------- Oshawa	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
318---------- Mayer	Fair	Fair	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
320B, 320C2--------- Tallula	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
342B---------- Kingsley	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
342C---------- Kingsley	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
342E, 342F---------- Kingsley	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
344---------- Quam	Fair	Fair	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
377B---------- Merton	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
378---------- Maxfield	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
382B---------- Blooming	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Poor.
408---------- Faxon	Fair	Fair	Fair	Poor	Poor	Good	Fair	Fair	Poor	Fair.
409B---------- Etter	Fair	Fair	Fair	Fair	Good	Poor	Very poor.	Good	Poor	Poor.
409C---------- Etter	Fair	Fair	Fair	Fair	Good	Very poor.	Very poor.	Good	Poor	Very poor.
411A, 411B---------- Waukegan	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.

TABLE 9.--WILDLIFE HABITAT--Continued

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
411C---------- Waukegan	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
414---------- Hamel	Good	Good	Fair	Good	Fair	Good	Good	Good	Fair	Good.
415A, 415B, 415C--- Kanaranzi	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
449B---------- Crystal Lake	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
454B, 454C--------- Mahtomedi	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
454E---------- Mahtomedi	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
463---------- Minneiska	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
465---------- Kalmarville	Poor	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
495---------- Zumbro	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Poor.
522---------- Boots	Good	Good	Poor	Good	Poor	Good	Good	Good	Good	Good.
539---------- Palms	Good	Poor	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
540---------- Seelyeville	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
545---------- Rondeau	Fair	Fair	Poor	Poor	Very poor.	Good	Good	Fair	Very poor.	Good.
611C, 611D--------- Hawick	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
611E, 611F--------- Hawick	Very poor.	Very poor.	Fair	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.
857A*, 857B*: Urban land.										
Waukegan----------	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
858C*: Urban land.										
Chetek----------	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
860C*: Urban land.										
Lester----------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
861C*: Urban land.										

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

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
861C*:										
Kingsley	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
861E*:										
Urban land.										
Kingsley	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
865B*:										
Urban land.										
Hubbard	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
880F*:										
Brodale	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Poor	Very poor.
Rock outcrop.										
888B*:										
Kingsley	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Lester	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
888C*, 888D*:										
Kingsley	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Lester	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
889B*:										
Wadena	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Hawick	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
889C*:										
Wadena	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Hawick	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
889D*:										
Wadena.										
Hawick	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
895B*:										
Kingsley	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Mahtomedi	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
Spencer	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

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
895C*:										
Kingsley	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Mahtomedi	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
Spencer	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
896E*, 896F*:										
Kingsley	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Mahtomedi	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
963C2*:										
Timula	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Bold	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
963D2*, 963E2*:										
Timula	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Bold	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
1013*. Pits										
1027*. Udorthents										
1029*. Pits										
1039*. Urban land										
1055*:										
Aquolls.										
Histosols.										
1072*. Udorthents										
1815 Zumbro	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Poor.
1816. Kennebec Variant										
1821 Algansee	Poor	Fair	Fair	Poor	Poor	Fair	Fair	Fair	Poor	Fair.
1824 Quam	Very poor.	Poor	Very poor.	Very poor.	Very poor.	Good	Good	Very poor.	Very poor.	Good.
1825C Seelyeville	Poor	Poor	Poor	Poor	Poor	Good	Fair	Poor	Poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

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
1827A, 1827B, 1827C---------- Waukegan	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
1848B---------- Sparta	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
1894B---------- Winnebago	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
1895B---------- Carmi	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
1896B*:										
Ostrander----------	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Carmi----------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
1898F*:										
Etter.										
Brodale----------	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Poor	Very poor.
1902B---------- Jewett	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--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
2B Ostrander	Slight	Slight	Slight	Slight	Moderate: frost action.	Slight.
2C Ostrander	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
7A, 7B Hubbard	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Severe: droughty.
7C Hubbard	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
7D Hubbard	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
8A, 8B Sparta	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
12C Emmert	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
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.
39A Wadena	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Slight.
39B Wadena	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Slight.
39B2 Wadena	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Slight.
39C, 39C2 Wadena	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.
39D Wadena	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
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.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
49B Antigo	Severe: cutbanks cave.	Moderate: shrink-swell.	Slight	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
81B Boone	Severe: cutbanks cave.	Slight	Moderate: depth to rock.	Moderate: slope.	Slight	Moderate: droughty, thin layer.
81C Boone	Severe: cutbanks cave.	Moderate: slope.	Moderate: depth to rock, slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope, thin layer.

TABLE 10.--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
81E---------- Boone	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
94C---------- Terril	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: low strength.	Moderate: slope.
98---------- Colo	Severe: wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
100A, 100B-------- Copaston	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: thin layer.
100C---------- 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.
106B---------- Lester	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
106C, 106C2------- Lester	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
106D2---------- Lester	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
109---------- Cordova	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength.	Moderate: wetness.
113---------- Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
114---------- Glencoe	Severe: ponding.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding.	Severe: flooding, ponding, low strength.	Severe: ponding, low strength, frost action.	Severe: ponding.
129---------- Cylinder	Severe: cutbanks cave, wetness.	Moderate: shrink-swell, wetness.	Severe: wetness.	Moderate: shrink-swell, wetness.	Severe: frost action.	Slight.
150B---------- Spencer	Moderate: dense layer, wetness.	Slight---------	Moderate: wetness.	Moderate: slope.	Severe: frost action.	Slight.
151C---------- Burkhardt	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
151D---------- Burkhardt	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
155B---------- Chetek	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: large stones, droughty.
155C---------- Chetek	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: large stones, slope, droughty.
155E---------- Chetek	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

TABLE 10.--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
173F---------- Frontenac	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
176---------- Garwin	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: frost action, low strength, shrink-swell.	Moderate: wetness.
177A---------- Gotham	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
177B---------- Gotham	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
177C---------- Gotham	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
189---------- Auburndale	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
203B---------- Joy	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: low strength, frost action.	Slight.
208---------- Kato	Severe: cutbanks cave, wetness.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: low strength, frost action.	Moderate: wetness.
213B---------- Klinger	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action, low strength.	Slight.
226---------- Lawson	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, frost action.	Moderate: wetness, flooding.
239---------- Le Sueur	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action, low strength.	Slight.
250---------- Kennebec	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.
251D, 251E-------- Marlean	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
252---------- Marshan	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Moderate: wetness.
253---------- Maxcreek	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
255---------- Mayer	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength.	Moderate: wetness.
279B---------- Otterholt	Moderate: dense layer.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
279C---------- Otterholt	Moderate: dense layer, slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.

TABLE 10.--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
283A---------- Plainfield	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
283B---------- Plainfield	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
283D---------- Plainfield	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope, droughty.
285A---------- Port Byron	Slight---------	Slight---------	Slight---------	Slight---------	Severe: low strength, frost action.	Slight.
285B---------- Port Byron	Slight---------	Slight---------	Slight---------	Moderate: slope.	Severe: low strength, frost action.	Slight.
285C---------- Port Byron	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
299A---------- Rockton	Moderate: depth to rock, too clayey.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, frost action.	Moderate: thin layer.
299B---------- Rockton	Moderate: depth to rock, too clayey.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.	Moderate: thin layer.
299C---------- Rockton	Moderate: depth to rock, too clayey, slope.	Moderate: shrink-swell, slope.	Moderate: depth to rock, slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope, thin layer.
301B---------- Lindstrom	Slight---------	Slight---------	Slight---------	Slight---------	Severe: frost action.	Slight.
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.
318---------- Mayer	Severe: cutbanks cave, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: frost action, ponding.	Severe: ponding.
320B---------- Tallula	Slight---------	Slight---------	Slight---------	Moderate: slope.	Severe: frost action.	Slight.
320C2---------- Tallula	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: frost action.	Moderate: slope.
342B---------- Kingsley	Moderate: dense layer.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Slight.
342C---------- Kingsley	Moderate: dense layer, slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.
342E, 342F-------- Kingsley	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
344---------- Quam	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.

TABLE 10.--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
377B---------- Merton	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Slight.
378---------- Maxfield	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
382B---------- Blooming	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, low strength.	Slight.
408---------- Faxon	Severe: depth to rock, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness, depth to rock.	Severe: flooding, wetness.	Severe: wetness, flooding, frost action.	Severe: wetness, flooding.
409B---------- Etter	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Slight.
409C---------- Etter	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.
411A, 411B-------- Waukegan	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Severe: low strength.	Slight.
411C---------- Waukegan	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: low strength.	Moderate: slope.
414---------- Hamel	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
415A---------- Kanaranzi	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Moderate: frost action.	Slight.
415B---------- Kanaranzi	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Slight.
415C---------- Kanaranzi	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
449B---------- Crystal Lake	Moderate: cutbanks cave, wetness.	Moderate: shrink-swell.	Moderate: wetness.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
454B---------- Mahtomedi	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: small stones, droughty.
454C---------- Mahtomedi	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: small stones, droughty, slope.
454E---------- Mahtomedi	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
463---------- Minneiska	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.
465---------- Kalmarville	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding, frost action.	Severe: wetness, flooding.
495---------- Zumbro	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.	Slight.

TABLE 10.--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
522---------- Boots	Severe: excess humus, ponding.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding, low strength.	Severe: ponding, flooding, frost action.	Severe: ponding, flooding, excess humus.
539---------- Palms	Severe: excess humus, ponding.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding, frost action.	Severe: flooding, ponding, excess humus.
540---------- Seelyeville	Severe: excess humus, ponding.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding, low strength.	Severe: ponding, flooding, frost action.	Severe: ponding, flooding, excess humus.
545---------- Rondeau	Severe: excess humus, ponding.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding, low strength.	Severe: ponding, flooding, frost action.	Severe: ponding, flooding, excess humus.
611C---------- Hawick	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
611D, 611E, 611F-- Hawick	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
857A*: Urban land.						
Waukegan---------	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Severe: low strength.	Slight.
857B*: Urban land.						
Waukegan---------	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Severe: low strength.	Slight.
858C*: Urban land.						
Chetek----------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: large stones, slope, droughty.
860C*: Urban land.						
Lester----------	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
861C*: Urban land.						
Kingsley---------	Moderate: dense layer, slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.
861E*: Urban land.						
Kingsley---------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
865B*: Urban land.						

See footnote at end of table.

TABLE 10.--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
865B*:						
Hubbard	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Severe: droughty.
880F*:						
Brodale	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: small stones, droughty, slope.
Rock outcrop.						
888B*:						
Kingsley	Moderate: dense layer.	Slight	Slight	Moderate: slope.	Slight	Slight.
Lester	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
888C*:						
Kingsley	Moderate: dense layer, slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.
Lester	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
888D*:						
Kingsley	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Lester	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
889B*:						
Wadena	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Slight.
Hawick	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Severe: droughty.
889C*:						
Wadena	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.
Hawick	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
889D*:						
Wadena	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Hawick	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
895B*:						
Kingsley	Moderate: dense layer.	Slight	Slight	Moderate: slope.	Slight	Slight.
Mahtomedi	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: small stones, droughty.

See footnote at end of table.

TABLE 10.--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
895B*:						
Spencer	Moderate: dense layer, wetness.	Slight	Moderate: wetness.	Moderate: slope.	Severe: frost action.	Slight.
895C*:						
Kingsley	Moderate: dense layer, slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.
Mahtomedi	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: small stones, droughty, slope.
Spencer	Moderate: dense layer, wetness, slope.	Moderate: slope.	Moderate: wetness, slope.	Severe: slope.	Severe: frost action.	Moderate: slope.
896E*, 896F*:						
Kingsley	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Mahtomedi	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
963C2*:						
Timula	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: frost action.	Moderate: slope.
Bold	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: frost action.	Moderate: slope.
963D2*, 963E2*:						
Timula	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, frost action.	Severe: slope.
Bold	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, frost action.	Severe: slope.
1013*. Pits						
1027*. Udorthents						
1029*. Pits						
1039*. Urban land						
1055*:						
Aquolls.						
Histosols.						
1072*. Udorthents						
1815 Zumbro	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Slight.

See footnote at end of table.

TABLE 10.--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
1816--Kennebec Variant	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
1821--Algansee	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding.	Moderate: flooding, wetness.
1824--Quam	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
1825C--Seelyeville	Severe: excess humus, wetness.	Severe: wetness, low strength.	Severe: wetness.	Severe: wetness, slope, low strength.	Severe: wetness, frost action.	Severe: wetness, excess humus.
1827A--Waukegan	Severe: depth to rock, cutbanks cave.	Moderate: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock.	Moderate: thin layer.
1827B--Waukegan	Severe: depth to rock, cutbanks cave.	Moderate: depth to rock.	Severe: depth to rock.	Moderate: slope, depth to rock.	Moderate: depth to rock.	Moderate: thin layer.
1827C--Waukegan	Severe: depth to rock, cutbanks cave.	Moderate: depth to rock, slope.	Severe: depth to rock.	Severe: slope.	Moderate: depth to rock, slope.	Moderate: thin layer, slope.
1848B--Sparta	Severe: cutbanks cave.	Slight	Moderate: depth to rock.	Moderate: slope.	Slight	Moderate: droughty.
1894B--Winnebago	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: frost action, shrink-swell.	Slight.
1895B--Carmi	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
1896B*:						
Ostrander	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
Carmi	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
1898F*:						
Etter	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Brodale	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: small stones, droughty, slope.
1902B--Jewett	Moderate: dense layer.	Moderate: shrink-swell.	Slight	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--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
2B Ostrander	Slight	Moderate: seepage, slope.	Slight	Slight	Fair: small stones.
2C Ostrander	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: small stones, slope.
7A, 7B Hubbard	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
7C Hubbard	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
7D Hubbard	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
8A, 8B Sparta	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
12C Emmert	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
27A, 27B Dickinson	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
39A, 39B, 39B2 Wadena	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
39C, 39C2 Wadena	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
39D Wadena	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, too sandy, slope.	Severe: seepage, slope.	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, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
49B Antigo	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.

TABLE 11.--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
81B Boone	Severe: depth to rock, poor filter.	Severe: seepage, depth to rock.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim, seepage, too sandy.
81C Boone	Severe: depth to rock, poor filter.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim, seepage, too sandy.
81E Boone	Severe: depth to rock, poor filter, slope.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage, slope.	Severe: depth to rock, seepage, slope.	Poor: area reclaim, seepage, too sandy.
94C Terril	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
98 Colo	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness, hard to pack.
100A, 100B Copaston	Severe: depth to rock.	Severe: seepage, depth to rock.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim.
100C Copaston	Severe: depth to rock.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim.
106B Lester	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
106C, 106C2 Lester	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
106D2 Lester	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
109 Cordova	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
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.
129 Cylinder	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, seepage.
150B Spencer	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: small stones, wetness.
151C Burkhardt	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.

TABLE 11.--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
151D---------- Burkhardt	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
155B---------- Chetek	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
155C---------- Chetek	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
155E---------- Chetek	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
173F---------- Frontenac	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: small stones, slope.
176---------- Garwin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
177A, 177B---------- Gotham	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
177C---------- Gotham	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
189---------- Auburndale	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
203B---------- Joy	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
208---------- Kato	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
213B---------- Klinger	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
226---------- Lawson	Severe: flooding, wetness.	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
239---------- Le Sueur	Severe: wetness.	Severe: wetness.	Moderate: wetness, too clayey.	Moderate: wetness.	Fair: too clayey, wetness.
250---------- Kennebec	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
251D, 251E---------- Marlean	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope, large stones.	Severe: seepage, slope.	Poor: small stones, slope.

TABLE 11.--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
252---------- Marshan	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
253---------- Maxcreek	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
255---------- Mayer	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness, seepage, too sandy.	Severe: wetness, seepage.	Poor: wetness, too sandy, seepage.
279B---------- Otterholt	Moderate: percs slowly.	Moderate: seepage, slope.	Slight----------	Slight----------	Good.
279C---------- Otterholt	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
283A, 283B---------- Plainfield	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
283D---------- Plainfield	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
285A---------- Port Byron	Slight----------	Moderate: seepage.	Slight----------	Slight----------	Good.
285B---------- Port Byron	Slight----------	Moderate: seepage, slope.	Slight----------	Slight----------	Good.
285C---------- Port Byron	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
299A, 299B---------- Rockton	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
299C---------- Rockton	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
301B---------- Lindstrom	Slight----------	Moderate: slope, seepage.	Slight----------	Slight----------	Good.
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.
318---------- Mayer	Severe: ponding.	Severe: ponding, seepage, flooding.	Severe: seepage, ponding, too sandy.	Severe: ponding, seepage.	Poor: ponding, too sandy, seepage.
320B---------- Tallula	Slight----------	Moderate: slope, seepage.	Slight----------	Slight----------	Good.
320C2---------- Tallula	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.

TABLE 11.--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
342B---------- Kingsley	Severe: percs slowly.	Moderate: seepage, slope.	Slight----------	Slight----------	Fair: small stones.
342C---------- Kingsley	Severe: percs slowly.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: small stones, slope.
342E, 342F---------- Kingsley	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
344---------- Quam	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
377B---------- Merton	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
378---------- Maxfield	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
382B---------- Blooming	Slight----------	Moderate: seepage, slope.	Slight----------	Slight----------	Good.
408---------- Faxon	Severe: flooding, depth to rock, wetness.	Severe: depth to rock, wetness.	Severe: flooding, depth to rock, wetness.	Severe: flooding, depth to rock, wetness.	Poor: area reclaim, wetness.
409B---------- Etter	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
409C---------- Etter	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
411A, 411B---------- Waukegan	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
411C---------- Waukegan	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
414---------- Hamel	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
415A, 415B---------- Kanaranzi	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
415C---------- Kanaranzi	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
449B---------- Crystal Lake	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
454B---------- Mahtomedi	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.

TABLE 11.--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
454C---------- Mahtomedi	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
454E---------- Mahtomedi	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
463---------- Minneiska	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Fair: wetness.
465---------- Kalmarville	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: wetness.
495---------- Zumbro	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: too sandy, thin layer.
522---------- Boots	Severe: flooding, ponding.	Severe: seepage, flooding, excess humus.	Severe: flooding, seepage, ponding.	Severe: flooding, seepage, ponding.	Poor: ponding, excess humus.
539---------- Palms	Severe: subsides, ponding, flooding.	Severe: seepage, excess humus, ponding.	Severe: flooding, ponding, excess humus.	Severe: flooding, ponding, seepage.	Poor: ponding, excess humus.
540---------- Seelyeville	Severe: flooding, ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: flooding, seepage, ponding.	Severe: flooding, seepage, ponding.	Poor: ponding, excess humus.
545---------- Rondeau	Severe: flooding, ponding, percs slowly.	Severe: seepage, flooding, excess humus.	Severe: flooding, ponding, excess humus.	Severe: flooding, seepage, ponding.	Poor: ponding, excess humus.
611C---------- Hawick	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
611D, 611E, 611F---- Hawick	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
857A*, 857B*: Urban land.					
Waukegan----------	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
858C*: Urban land.					
Chetek----------	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.

See footnote at end of table.

TABLE 11.--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
860C*: Urban land.					
Lester	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
861C*: Urban land.					
Kingsley	Severe: percs slowly.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: small stones, slope.
861E*: Urban land.					
Kingsley	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
865B*: Urban land.					
Hubbard	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
880F*: Brodale	Severe: slope.	Severe: slope, large stones.	Severe: depth to rock, slope, large stones.	Severe: slope.	Poor: small stones, slope.
Rock outcrop.					
888B*: Kingsley	Severe: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Fair: small stones.
Lester	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
888C*: Kingsley	Severe: percs slowly.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: small stones, slope.
Lester	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
888D*: Kingsley	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Lester	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
889B*: Wadena	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.

See footnote at end of table.

TABLE 11.--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
889B*:					
Hawick	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
889C*:					
Wadena	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Hawick	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
889D*:					
Wadena	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, too sandy, slope.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
Hawick	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
895B*:					
Kingsley	Severe: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Fair: small stones.
Mahtomedi	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Spencer	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: small stones, wetness.
895C*:					
Kingsley	Severe: percs slowly.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: small stones, slope.
Mahtomedi	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Spencer	Severe: wetness.	Severe: slope, wetness.	Severe: wetness.	Severe: wetness.	Fair: small stones, slope, wetness.
896E*, 896F*:					
Kingsley	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Mahtomedi	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.

See footnote at end of table.

TABLE 11.--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
963C2*:					
Timula	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Bold	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
963D2*, 963E2*:					
Timula	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Bold	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
1013*. Pits					
1027*. Udorthents					
1029*. Pits					
1039*. Urban land					
1055*:					
Aquolls.					
Histosols.					
1072*. Udorthents					
1815 Zumbro	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: too sandy, thin layer.
1816 Kennebec Variant	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
1821 Algansee	Severe: flooding, wetness, poor filter.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: seepage, too sandy, wetness.
1824 Quam	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
1825C Seelyeville	Severe: wetness, percs slowly.	Severe: seepage, slope, excess humus.	Severe: wetness, excess humus.	Severe: seepage, wetness.	Poor: wetness, excess humus.
1827A, 1827B Waukegan	Severe: depth to rock, poor filter.	Severe: seepage, depth to rock.	Severe: depth to rock, seepage, too sandy.	Severe: depth to rock, seepage.	Poor: area reclaim, seepage, too sandy.
1827C Waukegan	Severe: depth to rock, poor filter.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage, too sandy.	Severe: depth to rock, seepage.	Poor: area reclaim, seepage, too sandy.
1848B Sparta	Severe: poor filter.	Severe: seepage.	Severe: depth to rock, too sandy.	Severe: seepage.	Poor: seepage, too sandy.

See footnote at end of table.

TABLE 11.--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
1894B---------- Winnebago	Slight----------	Moderate: seepage, slope.	Moderate: too clayey.	Slight----------	Fair: too clayey, small stones.
1895B---------- Carmi	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
1896B*:					
Ostrander----------	Slight----------	Moderate: seepage, slope.	Slight----------	Slight----------	Fair: small stones.
Carmi----------	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
1898F*:					
Etter----------	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
Brodale----------	Severe: slope.	Severe: slope, large stones.	Severe: depth to rock, slope, large stones.	Severe: slope.	Poor: small stones, slope.
1902B---------- Jewett	Moderate: percs slowly.	Moderate: seepage, slope.	Slight----------	Slight----------	Fair: large stones.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--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
2B Ostrander	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
2C Ostrander	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
7A, 7B, 7C Hubbard	Good	Probable	Improbable: too sandy.	Poor: too sandy.
7D Hubbard	Fair: slope.	Probable	Improbable: too sandy.	Poor: slope, too sandy.
8A, 8B Sparta	Good	Probable	Improbable: too sandy.	Fair: too sandy.
12C Emmert	Good	Probable	Probable	Poor: small stones, area reclaim.
27A, 27B Dickinson	Good	Probable	Improbable: too sandy.	Good.
39A, 39B, 39B2, 39C, 39C2 Wadena	Good	Probable	Probable	Poor: small stones, area reclaim.
39D Wadena	Fair: slope.	Probable	Probable	Poor: small stones, slope, 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.
49B Antigo	Good	Probable	Probable	Poor: area reclaim, small stones.
81B, 81C Boone	Poor: area reclaim.	Improbable: thin layer.	Improbable: too sandy.	Fair: too sandy, area reclaim.
81E Boone	Poor: area reclaim, slope.	Improbable: thin layer.	Improbable: too sandy.	Fair: too sandy, area reclaim.
94C Terril	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, small stones.
98 Colo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
100A, 100B, 100C Copaston	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
106B---------- Lester	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
106C, 106C2---------- Lester	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
106D2---------- Lester	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
109---------- Cordova	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
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.
129---------- Cylinder	Fair: wetness.	Probable----------	Improbable: too sandy.	Fair: area reclaim, small stones, thin layer.
150B---------- Spencer	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim.
151C---------- Burkhardt	Good----------	Probable----------	Probable----------	Poor: small stones, area reclaim.
151D---------- Burkhardt	Fair: slope.	Probable----------	Probable----------	Poor: small stones, area reclaim, slope.
155B, 155C---------- Chetek	Good----------	Probable----------	Probable----------	Poor: small stones, area reclaim.
155E---------- Chetek	Fair: slope.	Probable----------	Probable----------	Poor: small stones, area reclaim, slope.
173F---------- Frontenac	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim, slope.
176---------- Garwin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
177A, 177B, 177C------ Gotham	Good----------	Probable----------	Improbable: too sandy.	Poor: thin layer.
189---------- Auburndale	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
203B---------- Joy	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
208---------- Kato	Fair: wetness.	Probable----------	Improbable: too sandy.	Fair: small stones, area reclaim, thin layer.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
213B---------- Klinger	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
226---------- Lawson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
239---------- Le Sueur	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
250---------- Kennebec	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
251D, 251E---------- Marlean	Fair: large stones, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, slope.
252---------- Marshan	Fair: wetness.	Probable----------	Probable----------	Fair: area reclaim, thin layer.
253---------- Maxcreek	Fair: wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
255---------- Mayer	Fair: wetness.	Probable----------	Probable----------	Fair: area reclaim, thin layer.
279B---------- Otterholt	Good----------	Improbable: excess fines.	Improbable: excess fines.	Good.
279C---------- Otterholt	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
283A, 283B, 283D------ Plainfield	Good----------	Probable----------	Improbable: too sandy.	Poor: thin layer.
285A, 285B---------- Port Byron	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
285C---------- Port Byron	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
299A, 299B---------- Rockton	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones.
299C---------- Rockton	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, slope.
301B---------- Lindstrom	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
313---------- Spillville	Good----------	Improbable: excess fines.	Improbable: excess fines.	Good.
317---------- Oshawa	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
318---------- Mayer	Poor: wetness.	Probable----------	Probable----------	Poor: wetness.
320B---------- Tallula	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
320C2 Tallula	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
342B, 342C Kingsley	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
342E Kingsley	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, slope.
342F Kingsley	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, slope.
344 Quam	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
377B Merton	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
378 Maxfield	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim.
382B Blooming	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
408 Faxon	Poor: area reclaim, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, wetness.
409B, 409C Etter	Good	Probable	Improbable: too sandy.	Poor: area reclaim.
411A, 411B, 411C Waukegan	Good	Probable	Improbable: too sandy.	Fair: area reclaim, thin layer.
414 Hamel	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
415A, 415B, 415C Kanaranzi	Good	Probable	Probable	Poor: small stones, area reclaim.
449B Crystal Lake	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
454B, 454C Mahtomedi	Good	Probable	Improbable: too sandy.	Poor: too sandy, small stones, area reclaim.
454E Mahtomedi	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, small stones, area reclaim.
463 Minneiska	Good	Probable	Improbable: too sandy.	Good.
465 Kalmarville	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
495---------- Zumbro	Good----------	Probable----------	Improbable: too sandy.	Good.
522---------- Boots	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
539---------- Palms	Poor: wetness.	Improbable: excess humus, excess fines.	Improbable: excess humus, excess fines.	Poor: wetness, excess humus.
540---------- Seelyeville	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
545---------- Rondeau	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
611C---------- Hawick	Good----------	Probable----------	Probable----------	Poor: small stones, area reclaim.
611D, 611E---------- Hawick	Fair: slope.	Probable----------	Probable----------	Poor: small stones, area reclaim, slope.
611F---------- Hawick	Poor: slope.	Probable----------	Probable----------	Poor: small stones, area reclaim, slope.
857A*, 857B*: Urban land.				
Waukegan----------	Good----------	Probable----------	Improbable: too sandy.	Fair: area reclaim, thin layer.
858C*: Urban land.				
Chetek----------	Good----------	Probable----------	Probable----------	Poor: small stones, area reclaim.
860C*: Urban land.				
Lester----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
861C*: Urban land.				
Kingsley----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
861E*: Urban land.				
Kingsley----------	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
865B*: Urban land.				
Hubbard	Good	Probable	Improbable: too sandy.	Poor: too sandy.
880F*: Brodale	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim, slope.
Rock outcrop.				
888B*: Kingsley	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
Lester	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
888C*: Kingsley	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
Lester	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
888D*: Kingsley	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, slope.
Lester	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
889B*, 889C*: Wadena	Good	Probable	Probable	Poor: small stones, area reclaim.
Hawick	Good	Probable	Probable	Poor: small stones, area reclaim.
889D*: Wadena	Fair: slope.	Probable	Probable	Poor: small stones, slope, area reclaim.
Hawick	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
895B*: Kingsley	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
895B*:				
Mahtomedi	Good	Probable	Improbable: too sandy.	Poor: too sandy, small stones, area reclaim.
Spencer	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim.
895C*:				
Kingsley	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
Mahtomedi	Good	Probable	Improbable: too sandy.	Poor: too sandy, small stones, area reclaim.
Spencer	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, slope.
896E*:				
Kingsley	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, slope.
Mahtomedi	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, small stones, area reclaim.
896F*:				
Kingsley	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, slope.
Mahtomedi	Poor: slope.	Probable	Improbable: too sandy.	Poor: too sandy, small stones, area reclaim.
963C2*:				
Timula	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Bold	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
963D2*, 963E2*:				
Timula	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Bold	Fair: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
1013*. Pits				
1027*. Udorthents				
1029*. Pits				

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1039*. Urban land				
1055*: Aquolls.				
Histosols.				
1072*. Udorthents				
1815---- Zumbro	Good----	Probable----	Improbable: too sandy.	Fair: too sandy.
1816---- Kennebec Variant	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
1821---- Algansee	Fair: wetness.	Probable----	Improbable: too sandy.	Good.
1824---- Quam	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
1825C---- Seelyeville	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
1827A, 1827B, 1827C--- Waukegan	Poor: area reclaim.	Improbable: thin layer.	Improbable: too sandy.	Fair: area reclaim, small stones, thin layer.
1848B---- Sparta	Fair: area reclaim, thin layer.	Improbable: thin layer.	Improbable: too sandy.	Poor: thin layer.
1894B---- Winnebago	Good----	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
1895B---- Carmi	Good----	Probable----	Probable----	Poor: small stones, area reclaim.
1896B*: Ostrander----	Good----	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Carmi----	Good----	Probable----	Probable----	Poor: small stones, area reclaim.
1898F*: Etter----	Poor: slope.	Probable----	Improbable: too sandy.	Poor: area reclaim, slope.
Brodale----	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim, slope.
1902B---- Jewett	Good----	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, area reclaim.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--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
2B---------- Ostrander	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope----------	Favorable------	Favorable.
2C---------- Ostrander	Severe: slope.	Moderate: piping.	Deep to water	Slope----------	Slope----------	Slope.
7A, 7B---------- Hubbard	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
7C, 7D---------- Hubbard	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
8A, 8B---------- Sparta	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
12C---------- Emmert	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, slope.	Slope, too sandy.	Slope, droughty.
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.
39A---------- Wadena	Severe: seepage.	Severe: seepage, piping.	Deep to water	Favorable------	Too sandy------	Favorable.
39B, 39B2--------- Wadena	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope----------	Too sandy------	Favorable.
39C, 39C2, 39D---- Wadena	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope----------	Slope, too sandy.	Slope.
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, slope.	Severe: seepage.	Deep to water	Droughty, fast intake, slope.	Slope, too sandy.	Slope, droughty.
49B---------- Antigo	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, erodes easily.	Erodes easily, too sandy.	Erodes easily.
81B---------- Boone	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Depth to rock, too sandy.	Droughty, depth to rock.
81C, 81E---------- Boone	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Slope, depth to rock, too sandy.	Slope, droughty, depth to rock.
94C---------- Terril	Severe: slope.	Moderate: piping.	Deep to water	Slope----------	Slope----------	Slope.

TABLE 13.--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
98---------- Colo	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Flooding, wetness.	Wetness--------	Wetness.
100A---------- Copaston	Severe: depth to rock.	Severe: piping.	Deep to water	Depth to rock	Depth to rock	Depth to rock.
100B---------- Copaston	Severe: depth to rock.	Severe: piping.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
100C---------- Copaston	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
106B---------- Lester	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Slope----------	Erodes easily	Erodes easily.
106C, 106C2, 106D2---------- Lester	Severe: slope.	Severe: thin layer.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
109---------- Cordova	Moderate: seepage.	Severe: wetness.	Frost action---	Wetness--------	Wetness--------	Wetness.
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.
129---------- Cylinder	Severe: seepage.	Severe: seepage, piping.	Frost action, cutbanks cave.	Wetness--------	Wetness, too sandy.	Favorable.
150B---------- Spencer	Moderate: seepage, slope.	Severe: piping.	Slope, frost action.	Wetness, slope, rooting depth.	Erodes easily, wetness.	Erodes easily, rooting depth.
151C, 151D-------- Burkhardt	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
155B---------- Chetek	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
155C, 155E-------- Chetek	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
173F---------- Frontenac	Severe: seepage, slope.	Moderate: seepage, piping, large stones.	Deep to water	Soil blowing, slope.	Slope, large stones, soil blowing.	Large stones, slope.
176---------- Garwin	Moderate: seepage.	Severe: wetness.	Frost action---	Wetness--------	Wetness--------	Wetness.
177A, 177B-------- Gotham	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
177C---------- Gotham	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
189---------- Auburndale	Moderate: seepage.	Severe: thin layer, ponding.	Ponding, frost action.	Ponding, erodes easily.	Erodes easily, ponding.	Wetness, erodes easily.

TABLE 13.--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
203B---------- Joy	Moderate: seepage, slope.	Severe: thin layer.	Frost action, slope.	Wetness, slope.	Erodes easily, wetness.	Erodes easily.
208---------- Kato	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness--------	Wetness, too sandy.	Wetness.
213B---------- Klinger	Moderate: seepage, slope.	Moderate: wetness, piping.	Slope, frost action.	Wetness, slope.	Wetness, erodes easily.	Erodes easily.
226---------- Lawson	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Wetness, flooding.	Erodes easily, wetness.	Wetness, erodes easily.
239---------- Le Sueur	Moderate: seepage.	Moderate: wetness.	Frost action---	Wetness--------	Wetness--------	Favorable.
250---------- Kennebec	Moderate: seepage.	Moderate: thin layer, piping, wetness.	Deep to water	Flooding-------	Favorable------	Favorable.
251D, 251E-------- Marlean	Severe: seepage, slope.	Severe: seepage, large stones.	Deep to water	Large stones---	Slope, large stones.	Large stones, slope.
252---------- Marshan	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness--------	Wetness, too sandy.	Wetness.
253---------- Maxcreek	Moderate: seepage.	Severe: piping, wetness.	Frost action---	Wetness--------	Wetness--------	Wetness.
255---------- Mayer	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness--------	Wetness, too sandy.	Wetness.
279B---------- Otterholt	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Slope, erodes easily.	Erodes easily	Erodes easily.
279C---------- Otterholt	Severe: slope.	Severe: thin layer.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
283A, 283B-------- Plainfield	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
283D---------- Plainfield	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Droughty, slope.
285A---------- Port Byron	Moderate: seepage.	Moderate: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
285B---------- Port Byron	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
285C---------- Port Byron	Severe: slope.	Moderate: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
299A---------- Rockton	Moderate: seepage, depth to rock.	Severe: thin layer.	Deep to water	Depth to rock	Depth to rock	Depth to rock.

TABLE 13.--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
299B---------- Rockton	Moderate: seepage, depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
299C---------- Rockton	Severe: slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
301B---------- Lindstrom	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
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.
318---------- Mayer	Severe: seepage.	Severe: seepage, ponding.	Frost action, ponding, cutbanks cave.	Ponding--------	Ponding, too sandy.	Wetness.
320B---------- Tallula	Moderate: seepage.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
320C2--------- Tallula	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
342B---------- Kingsley	Moderate: slope.	Severe: piping.	Deep to water	Soil blowing, rooting depth, slope.	Soil blowing---	Rooting depth.
342C, 342E, 342F-- Kingsley	Severe: slope.	Severe: piping.	Deep to water	Soil blowing, rooting depth, slope.	Slope, soil blowing.	Slope, rooting depth.
344---------- Quam	Slight---------	Severe: piping, ponding.	Ponding, frost action.	Ponding--------	Ponding--------	Wetness, erodes easily.
377B---------- Merton	Moderate: seepage, slope.	Severe: piping.	Frost action, slope.	Wetness, slope.	Wetness--------	Favorable.
378---------- Maxfield	Moderate: seepage.	Severe: wetness.	Frost action---	Wetness, rooting depth.	Wetness--------	Wetness, rooting depth.
382B---------- Blooming	Moderate: slope, seepage.	Moderate: piping.	Deep to water	Slope----------	Favorable------	Favorable.
408---------- Faxon	Moderate: seepage, depth to rock.	Severe: piping, wetness.	Depth to rock, flooding, frost action.	Wetness, depth to rock, flooding.	Depth to rock, wetness.	Wetness, depth to rock.
409B---------- Etter	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing, slope.	Too sandy, soil blowing.	Favorable.
409C---------- Etter	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Soil blowing, slope.	Slope, too sandy, soil blowing.	Slope.
411A---------- Waukegan	Severe: seepage.	Severe: seepage.	Deep to water	Favorable------	Erodes easily, too sandy.	Erodes easily.
411B---------- Waukegan	Severe: seepage.	Severe: seepage.	Deep to water	Slope----------	Erodes easily, too sandy.	Erodes easily.

TABLE 13.--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
411C---------- Waukegan	Severe: seepage, slope.	Severe: seepage.	Deep to water	Slope----------	Slope, erodes easily, too sandy.	Slope, erodes easily.
414---------- Hamel	Moderate: seepage.	Severe: wetness.	Frost action---	Wetness--------	Wetness--------	Wetness.
415A---------- Kanaranzi	Severe: seepage.	Severe: seepage.	Deep to water	Favorable------	Too sandy------	Favorable.
415B---------- Kanaranzi	Severe: seepage.	Severe: seepage.	Deep to water	Slope----------	Too sandy------	Favorable.
415C---------- Kanaranzi	Severe: seepage, slope.	Severe: seepage.	Deep to water	Slope----------	Slope, too sandy.	Slope.
449B---------- Crystal Lake	Moderate: seepage, slope.	Severe: piping.	Frost action, slope.	Wetness, slope, erodes easily.	Erodes easily, wetness.	Erodes easily.
454B---------- Mahtomedi	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty, rooting depth.
454C, 454E-------- Mahtomedi	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty, rooting depth.
463---------- Minneiska	Severe: seepage.	Severe: piping.	Deep to water	Flooding-------	Favorable------	Favorable.
465---------- Kalmarville	Moderate: seepage.	Severe: piping, seepage.	Flooding, frost action.	Wetness, flooding.	Wetness--------	Wetness.
495---------- Zumbro	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing---	Too sandy, soil blowing.	Favorable.
522---------- Boots	Severe: seepage.	Severe: excess humus, ponding.	Ponding, flooding, subsides.	Ponding, soil blowing, flooding.	Ponding, soil blowing.	Wetness.
539---------- Palms	Severe: seepage.	Severe: excess humus, ponding.	Ponding, flooding, subsides.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
540---------- Seelyeville	Severe: seepage.	Severe: excess humus, ponding.	Ponding, flooding, subsides.	Ponding, soil blowing, flooding.	Ponding, soil blowing.	Wetness.
545---------- Rondeau	Severe: seepage.	Severe: excess humus, ponding.	Ponding, flooding, subsides.	Ponding, soil blowing, percs slowly.	Ponding, soil blowing.	Wetness.
611C, 611D-------- Hawick	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
611E, 611F-------- Hawick	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
857A*: Urban land.						
Waukegan----------	Severe: seepage.	Severe: seepage.	Deep to water	Favorable------	Erodes easily, too sandy.	Erodes easily.

See footnote at end of table.

TABLE 13.--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
857B*: Urban land.						
Waukegan	Severe: seepage.	Severe: seepage.	Deep to water	Slope	Erodes easily, too sandy.	Erodes easily.
858C*: Urban land.						
Chetek	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
860C*: Urban land.						
Lester	Severe: slope.	Severe: thin layer.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
861C*, 861E*: Urban land.						
Kingsley	Severe: slope.	Severe: piping.	Deep to water	Soil blowing, rooting depth, slope.	Slope, soil blowing.	Slope, rooting depth.
865B*: Urban land.						
Hubbard	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
880F*: Brodale	Severe: slope.	Severe: seepage, large stones.	Deep to water	Large stones, droughty, slope.	Slope, large stones.	Large stones, slope, droughty.
Rock outcrop.						
888B*: Kingsley	Moderate: slope.	Severe: piping.	Deep to water	Soil blowing, rooting depth, slope.	Soil blowing	Rooting depth.
Lester	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Slope	Erodes easily	Erodes easily.
888C*, 888D*: Kingsley	Severe: slope.	Severe: piping.	Deep to water	Soil blowing, rooting depth, slope.	Slope, soil blowing.	Slope, rooting depth.
Lester	Severe: slope.	Severe: thin layer.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
889B*: Wadena	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope	Too sandy	Favorable.
Hawick	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
889C*, 889D*: Wadena	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope	Slope, too sandy.	Slope.

See footnote at end of table.

TABLE 13.--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
889C*, 889D*:						
Hawick	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
895B*:						
Kingsley	Moderate: slope.	Severe: piping.	Deep to water	Soil blowing, rooting depth, slope.	Soil blowing	Rooting depth.
Mahtomedi	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty, rooting depth.
Spencer	Moderate: seepage, slope.	Severe: piping.	Slope, frost action.	Wetness, slope, rooting depth.	Erodes easily, wetness.	Erodes easily, rooting depth.
895C*:						
Kingsley	Severe: slope.	Severe: piping.	Deep to water	Soil blowing, rooting depth, slope.	Slope, soil blowing.	Slope, rooting depth.
Mahtomedi	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty, rooting depth.
Spencer	Severe: slope.	Severe: piping.	Slope, frost action.	Wetness, slope, rooting depth.	Slope, erodes easily, wetness.	Slope, erodes easily, rooting depth.
896E*, 896F*:						
Kingsley	Severe: slope.	Severe: piping.	Deep to water	Soil blowing, rooting depth, slope.	Slope, soil blowing.	Slope, rooting depth.
Mahtomedi	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty, rooting depth.
963C2*, 963D2*, 963E2*:						
Timula	Severe: slope.	Severe: piping.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
Bold	Severe: slope.	Severe: piping.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
1013*. Pits						
1027*. Udorthents						
1029*. Pits						
1039*. Urban land						
1055*: Aquolls.						
Histosols.						
1072*. Udorthents						

See footnote at end of table.

TABLE 13.--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
1815--Zumbro	Severe: seepage.	Severe: seepage, piping.	Deep to water	Fast intake, soil blowing.	Too sandy, soil blowing.	Favorable.
1816--Kennebec Variant	Moderate: seepage.	Severe: ponding.	Ponding, frost action.	Ponding	Erodes easily, ponding.	Wetness, erodes easily.
1821--Algansee	Severe: seepage.	Severe: seepage, piping, wetness.	Flooding, cutbanks cave.	Wetness, droughty.	Wetness, too sandy, soil blowing.	Wetness, droughty.
1824--Quam	Slight	Severe: piping, ponding.	Ponding, frost action.	Ponding	Ponding	Wetness, erodes easily.
1825C--Seelyeville	Severe: seepage, slope.	Severe: excess humus, wetness.	Subsides, frost action, slope.	Wetness, soil blowing, slope.	Slope, wetness, soil blowing.	Wetness, slope.
1827A--Waukegan	Severe: seepage.	Severe: seepage.	Deep to water	Depth to rock	Depth to rock, too sandy.	Depth to rock.
1827B--Waukegan	Severe: seepage.	Severe: seepage.	Deep to water	Depth to rock, slope.	Depth to rock, too sandy.	Depth to rock.
1827C--Waukegan	Severe: seepage, slope.	Severe: seepage.	Deep to water	Depth to rock, slope.	Slope, depth to rock, too sandy.	Slope, depth to rock.
1848B--Sparta	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
1894B--Winnebago	Moderate: seepage, slope.	Moderate: thin layer, piping.	Deep to water	Slope	Favorable	Favorable.
1895B--Carmi	Severe: seepage.	Severe: seepage.	Deep to water	Soil blowing, rooting depth, slope.	Too sandy, soil blowing.	Rooting depth.
1896B*:						
Ostrander	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Favorable	Favorable.
Carmi	Severe: seepage.	Severe: seepage.	Deep to water	Soil blowing, rooting depth, slope.	Too sandy, soil blowing.	Rooting depth.
1898F*:						
Etter	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Soil blowing, slope.	Slope, too sandy, soil blowing.	Slope.
Brodale	Severe: slope.	Severe: seepage, large stones.	Deep to water	Large stones, droughty, slope.	Slope, large stones.	Large stones, slope, droughty.
1902B--Jewett	Moderate: seepage, slope.	Severe: piping.	Deep to water	Rooting depth, slope.	Favorable	Rooting depth.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--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	
2B, 2C----------	0-17	Loam----------	CL-ML, CL	A-4, A-6	0	100	98-100	90-95	70-90	25-40	5-15
Ostrander	17-53	Loam, sandy clay loam, sandy loam.	CL, SC	A-6	0-2	95-100	75-98	65-90	45-65	25-35	10-15
	53-60	Loam----------	CL	A-6	0-1	95-100	90-98	80-95	50-75	25-40	10-20
7A, 7B, 7C, 7D---	0-16	Loamy sand-------	SM, SP-SM	A-2	0	98-100	95-100	50-80	10-25	<20	NP
Hubbard	16-38	Sand, coarse sand, loamy sand.	SP-SM, SW-SM	A-1, A-3, A-2-4	0	98-100	70-100	25-75	5-12	<20	NP
	38-60	Sand, coarse sand	SP, SW	A-1, A-3	0	95-100	70-100	20-70	2-5	<20	NP
8A, 8B----------	0-25	Loamy fine sand	SM	A-2, A-4	0	85-100	85-100	50-95	15-50	---	NP
Sparta	25-60	Loamy fine sand, fine sand, sand.	SP-SM, SM	A-2, A-3, A-4	0	85-100	85-100	50-95	5-50	---	NP
12C---------------	0-4	Gravelly sandy loam.	SM, SM-SC, SP-SM	A-1	0-10	80-90	65-85	30-50	10-20	<20	NP-4
Emmert	4-60	Very gravelly coarse sand.	GW, GP, SP, SW	A-1	0-10	35-60	25-45	10-25	0-5	---	NP
27A, 27B---------	0-16	Sandy loam-------	SM, SC, SM-SC	A-4, A-2	0	100	100	85-95	30-50	15-30	NP-10
Dickinson	16-36	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, loamy sand.	SM, SP-SM	A-3, A-2	0	100	100	70-90	5-20	---	NP
39A, 39B---------	0-12	Loam----------	ML	A-4	0	95-100	80-100	75-95	50-65	25-40	2-10
Wadena	12-31	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
	31-60	Sand and gravel	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	45-100	40-95	10-80	2-10	---	NP
39B2--------------	0-9	Loam----------	ML	A-4	0	95-100	80-100	75-95	50-65	25-40	2-10
Wadena	9-31	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
	31-60	Sand and gravel	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	45-100	40-95	10-80	2-10	---	NP
39C---------------	0-12	Loam----------	ML	A-4	0	95-100	80-100	75-95	50-65	25-40	2-10
Wadena	12-31	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
	31-60	Sand and gravel	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	45-100	40-95	10-80	2-10	---	NP
39C2--------------	0-9	Loam----------	ML	A-4	0	95-100	80-100	75-95	50-65	25-40	2-10
Wadena	9-31	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
	31-60	Sand and gravel	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	45-100	40-95	10-80	2-10	---	NP
39D---------------	0-12	Loam----------	ML	A-4	0	95-100	80-100	75-95	50-65	25-40	2-10
Wadena	12-31	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
	31-60	Sand and gravel	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----------	0-13	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0-5	90-100	80-100	50-75	25-50	20-30	2-10
Estherville	13-21	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
	21-60	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

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

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	
42C---------- Salida	0-8	Gravelly coarse sandy loam.	SM, SP-SM	A-2, A-1	0-5	85-95	60-75	30-60	12-20	---	NP
	8-14	Gravelly loamy sand, gravelly coarse sand, gravelly loamy coarse sand.	SP, SW, GP, GP-GM	A-1	0-5	50-90	40-60	10-30	0-5	---	NP
	14-60	Very gravelly coarse sand, very gravelly sand.	SP, SW, GP, GP-GM	A-1	0-5	20-70	10-60	5-30	0-5	---	NP
49B---------- Antigo	0-8	Silt loam--------	ML, CL-ML	A-4	0-3	95-100	90-100	90-100	85-90	<25	2-7
	8-24	Silty clay loam, silt loam.	CL	A-6, A-7	0-3	95-100	90-100	90-100	85-95	30-45	10-25
	24-60	Stratified sand to gravel.	SP, SP-SM, GP, GP-GM	A-2, A-3, A-1	0-7	30-100	25-100	10-70	1-12	---	NP
81B, 81C, 81E---- Boone	0-8	Loamy fine sand	SM	A-2, A-4	0	100	100	50-90	15-50	---	NP
	8-24	Fine sand, coarse sand, loamy sand.	SM, SP-SM	A-2, A-3, A-1	0	75-100	75-100	40-80	5-35	---	NP
	24-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
94C---------- Terril	0-60	Loam----------	CL	A-6	0-5	100	95-100	70-90	60-80	30-40	10-20
98---------- Colo	0-20	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	95-100	25-40	5-15
	20-60	Silty clay loam, clay loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30
100A, 100B, 100C- Copaston	0-6	Loam----------	SM, ML	A-4	0	95-100	90-100	65-80	45-60	30-40	NP-10
	6-15	Fine sandy loam, sandy loam, loam.	SM	A-2, A-4	0-5	95-100	70-100	55-75	25-50	<35	NP-10
	15	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
106B, 106C, 106C2, 106D2---- Lester	0-6	Loam----------	ML, CL	A-6, A-4	0	95-100	90-100	80-95	50-70	30-40	5-15
	6-38	Clay loam, loam	CL	A-7, A-6	0-5	95-100	90-100	80-95	55-75	35-50	15-25
	38-60	Loam, clay loam	CL, CL-ML	A-6, A-4	0-5	95-100	90-100	75-90	50-70	20-40	5-20
109---------- Cordova	0-10	Silty clay loam	OL, ML, MH, OH	A-6, A-7	0	95-100	95-100	90-100	70-85	38-60	12-25
	10-20	Silty clay loam, clay loam.	CL	A-7	0	90-100	90-100	85-95	65-90	40-50	20-30
	20-60	Clay loam, loam	CL	A-6	0-5	90-100	90-100	80-95	55-70	30-40	12-20
113---------- Webster	0-14	Clay loam--------	CL, CH	A-7, A-6	0-5	100	95-100	85-95	70-90	35-60	15-30
	14-30	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
	30-60	Loam, sandy 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
	26-38	Loam, clay loam, silty clay loam.	CL	A-7, A-6	0	100	95-100	85-98	75-90	35-50	15-25
	38-60	Loam, clay loam	CL	A-6, A-7	0	98-100	90-98	80-98	70-85	35-50	15-25
129---------- Cylinder	0-12	Loam----------	CL	A-6, A-7	0	100	90-100	80-100	50-75	30-50	10-25
	12-25	Loam, clay loam	CL, SC	A-6	0	95-100	80-100	80-95	45-70	30-40	10-20
	25-60	Gravelly coarse sand, loamy sand.	SP-SM, SM	A-1, A-2, A-3	0-10	75-95	75-95	20-55	5-25	---	NP

TABLE 14.--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	
150B---------- Spencer	0-13	Silt loam--------	ML, CL, CL-ML	A-4	0	100	100	90-100	70-90	20-28	3-9
	13-45	Silt loam, silty clay loam.	CL	A-6	0	100	100	90-100	80-100	25-40	10-20
	45-60	Sandy loam, loam, gravelly sandy loam.	SM, SC, ML, CL	A-2, A-4, A-1, A-6	0-4	60-100	55-90	30-85	15-65	<30	NP-14
151C, 151D------- Burkhardt	0-12	Sandy loam-------	SM, SM-SC	A-2, A-4	0	95-100	95-100	60-70	25-40	<26	2-7
	12-22	Sandy loam, loam	SM, ML, SC, CL	A-2, A-4	0	95-100	85-100	60-95	25-60	15-30	2-10
	22-60	Stratified sand to gravel.	SP, SP-SM, GP, GP-GM	A-1	0	50-85	45-85	20-35	1-5	---	NP
155B, 155C, 155E- Chetek	0-7	Sandy loam-------	SM, SM-SC	A-2, A-4	0-15	80-100	75-100	45-70	25-40	<23	2-6
	7-14	Loam, sandy loam, gravelly sandy loam.	ML, CL, SM, SC	A-2, A-4, A-6, A-1	0-15	80-100	70-100	45-95	20-75	21-31	3-13
	14-60	Stratified sand to gravel.	SP, SP-SM	A-1	0-15	55-95	50-80	15-50	1-5	---	NP
173F---------- Frontenac	0-11	Loam----------	ML, CL	A-4, A-6	0	95-100	85-100	70-100	60-90	30-40	5-15
	11-24	Loam, silt loam	ML	A-4, A-6	0-10	95-100	75-100	70-90	60-85	30-40	5-15
	24-60	Cobbly loam, flaggy loam, channery loam.	SM, GM	A-2	25-50	45-85	35-75	30-55	25-35	30-40	5-10
176---------- Garwin	0-14	Silty clay loam	CL, CH	A-7	0	100	100	100	95-100	45-55	20-30
	14-28	Silty clay loam	CH, CL	A-7	0	100	100	100	95-100	45-55	25-35
	28-60	Silt loam--------	CL	A-6	0	100	100	100	95-100	30-40	15-20
177A, 177B------- Gotham	0-9	Loamy sand-------	SM, SP-SM	A-2, A-3, A-1	0	100	95-100	35-75	5-25	---	NP
	9-48	Loamy fine sand, loamy sand, fine sand.	SM, SP-SM, SP	A-2, A-3, A-1	0	95-100	75-100	35-75	3-25	---	NP
	48-60	Fine sand, loamy sand, sand.	SM, SP-SM, SP	A-2, A-3, A-1	0	95-100	75-100	35-75	1-20	---	NP
177C---------- Gotham	0-9	Loamy sand-------	SM, SP-SM	A-2, A-3, A-1	0	100	95-100	35-75	5-25	---	NP
	9-48	Loamy fine sand, loamy sand, fine sand.	SM, SP-SM, SP	A-2, A-3, A-1	0	95-100	75-100	35-75	3-25	---	NP
	38-60	Fine sand, loamy sand, sand.	SM, SP-SM, SP	A-2, A-3, A-1	0	95-100	75-100	35-75	1-20	---	NP
189---------- Auburndale	0-13	Silt loam--------	CL, ML, CL-ML	A-4, A-6	0	100	95-100	90-100	90-100	<35	2-15
	13-58	Silt loam--------	CL	A-6	0	100	95-100	90-100	85-100	25-35	10-17
	58-60	Sandy loam, gravelly sandy loam, loam.	SM, ML, CL-ML, SM-SC	A-4, A-2	0-5	75-95	65-95	40-90	20-70	<25	NP-7
203B---------- Joy	0-23	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	100	95-100	20-35	5-15
	23-55	Silt loam--------	CL	A-6	0	100	100	100	95-100	25-40	10-20
	55-60	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	100	95-100	20-35	5-15
208---------- Kato	0-23	Silty clay loam	CL, ML	A-6, A-7, A-4	0	100	95-100	90-95	70-95	35-50	8-23
	23-30	Silty clay loam, silt loam.	ML, CL	A-6, A-7, A-4	0	100	95-100	90-95	70-95	35-50	8-23
	30-60	Sand, coarse sand, gravelly coarse sand.	SP, SW, SP-SM, SW-SM	A-1, A-3, A-2	0-5	75-100	70-95	25-70	2-12	<20	NP
213B---------- Klinger	0-13	Silt loam--------	CL, ML	A-7	0	100	100	100	95-100	40-50	15-25
	13-28	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	20-30
	28-60	Loam, clay loam	CL	A-6	0-5	90-95	85-90	75-85	55-65	25-35	10-20

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

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	
226---------- Lawson	0-30	Silt loam--------	CL, CL-ML	A-4	0	100	100	90-100	80-100	20-30	5-10
	30-60	Silty clay loam, silt loam.	CL	A-6	0	100	100	90-100	80-100	20-40	10-25
239---------- Le Sueur	0-10	Loam----------	CL, ML, CL-ML	A-6, A-4	0	95-100	95-100	90-100	70-85	20-40	5-15
	10-53	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0	95-100	95-100	85-100	60-80	35-50	15-25
	53-60	Loam----------	CL-ML, CL	A-6, A-4	0-5	95-100	90-100	80-95	55-75	20-40	5-20
250---------- Kennebec	0-41	Silt loam--------	CL	A-6, A-7	0	100	100	95-100	90-100	25-45	10-20
	41-60	Silt loam, silty clay loam.	CL, CL-ML	A-6, A-4	0	100	100	95-100	90-100	25-40	5-15
251D, 251E------- Marlean	0-11	Loam----------	CL, CL-ML	A-4, A-6	5-15	75-95	70-90	60-85	50-85	20-30	5-15
	11-42	Loam, sandy clay loam, clay loam.	CL	A-6, A-7	0-10	85-95	80-90	70-85	50-85	35-45	15-20
	42	Flaggy loam, flaggy clay loam, flaggy sandy clay loam.	SM, SC, GM, GC	A-4, A-2, A-1	20-50	30-70	30-70	25-50	12-40	<20	NP-10
252---------- Marshan	0-14	Silty clay loam	CL	A-7, A-6	0	95-100	95-100	95-100	80-95	35-50	15-25
	14-32	Loam, sandy loam	CL, CL-ML, SM-SC, SC	A-6, A-4	0	95-100	75-100	70-90	40-75	25-40	5-15
	32-60	Coarse sand, gravelly coarse sand, sand.	SP, SW, SP-SM	A-1	0-3	65-95	45-95	20-45	2-5	---	NP
253---------- Maxcreek	0-17	Silty clay loam	CL, MH, ML, CH	A-7	0	100	100	95-100	92-100	40-55	15-25
	17-30	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	95-100	85-95	75-90	35-50	15-25
	30-60	Loam, clay loam	CL, ML, CL-ML	A-4, A-6	0-2	95-100	90-95	60-80	50-75	25-40	3-18
255---------- Mayer	0-17	Silt loam--------	CL, ML	A-6, A-4	0-2	95-100	85-100	70-90	50-85	30-40	5-15
	17-31	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
	31-60	Gravelly coarse sand, sand, coarse sand.	SP, SW, SP-SM	A-1	0-10	65-95	45-85	20-45	2-10	<20	NP
279B, 279C------- Otterholt	0-11	Silt loam--------	ML, CL-ML	A-4	0	100	100	90-100	70-90	20-26	3-7
	11-35	Silt loam--------	CL	A-6	0	100	100	95-100	80-95	25-40	10-20
	35-60	Sandy loam, loam, gravelly sandy loam.	ML, CL, SM, SC	A-2, A-4, A-6, A-1	0-4	60-100	55-90	30-85	15-65	<30	NP-14
283A, 283B, 283D- Plainfield	0-14	Loamy sand-------	SM, SP-SM	A-2, A-4, A-1	0	75-100	75-100	40-90	12-40	---	NP
	14-60	Sand, fine sand	SP, SM, SP-SM	A-3, A-1, A-2	0	75-100	75-100	40-90	1-15	---	NP
285A, 285B, 285C- Port Byron	0-19	Silt loam--------	CL	A-4, A-6	0	100	100	100	95-100	25-40	7-18
	19-60	Silt loam--------	CL	A-4, A-6	0	100	100	100	95-100	25-40	7-18
299A, 299B, 299C- Rockton	0-16	Loam----------	ML, CL-ML, CL	A-4	0	90-100	90-100	85-95	50-75	25-35	5-10
	16-35	Loam, sandy clay loam, clay loam.	CL, SC	A-6, A-7	0	90-100	90-100	75-90	45-70	30-45	10-20
	35	Weathered bedrock	---	---	---	---	---	---	---	---	---
301B---------- Lindstrom	0-34	Silt loam--------	ML	A-4	0	100	100	95-100	85-95	30-40	5-10
	34-60	Loam, silt loam, very fine sandy loam.	ML	A-4	0	100	95-100	75-95	50-90	25-35	NP-5

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

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	
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	0-37	Silty clay loam	MH, CH	A-7	0	95-100	95-100	95-100	90-100	50-70	20-40
	37-60	Loam, silt loam, silty clay loam.	CL	A-6	0	95-100	95-100	90-100	85-95	30-40	10-15
318---------- Mayer	0-19	Loam----------	CL, ML	A-6, A-4	0-2	95-100	85-100	70-90	50-85	30-40	5-15
	19-36	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
	36-60	Gravelly coarse sand, sand, coarse sand.	SP, SW, SP-SM	A-1	0-10	65-95	45-85	20-45	2-10	<20	NP
320B, 320C2------ Tallula	0-9	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	100	95-100	20-35	5-15
	9-27	Silt loam--------	CL	A-6	0	100	100	100	90-100	25-40	10-20
	27-60	Silt loam, silt	CL, CL-ML	A-4, A-6	0	100	100	100	85-100	20-35	5-15
342B, 342C, 342E, 342F---------- Kingsley	0-12	Sandy loam-------	SM	A-2, A-4	0-5	90-100	75-100	50-85	30-45	<20	NP
	12-38	Sandy loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4	0-5	90-100	75-95	50-75	25-45	10-20	3-8
	38-60	Sandy loam, coarse sandy loam.	SM, SM-SC	A-2, A-4	0-5	90-100	75-95	50-75	25-40	10-20	2-7
344---------- Quam	0-12	Silt loam--------	OL, ML	A-7, A-4, A-6, A-5	0	100	100	80-100	70-95	30-50	5-20
	12-45	Silty clay loam, silt loam, loam.	CL, ML	A-7, A-6, A-4	0	100	100	80-100	70-95	30-50	5-25
	45-60	Clay loam, silty clay loam, silt loam.	CL, ML, CL-ML	A-4, A-6, A-7	0	100	90-100	85-95	70-90	20-50	5-20
377B---------- Merton	0-15	Silt loam--------	CL-ML, CL	A-6, A-4	0	100	100	85-100	75-90	25-40	5-15
	15-37	Silt loam, loam, silty clay loam.	CL, CL-ML	A-6, A-4	0	100	100	85-100	65-80	25-40	5-15
	37-60	Loam, sandy loam	CL, ML, CL-ML	A-6, A-4	0-2	95-100	90-100	75-85	50-75	20-40	3-15
378---------- Maxfield	0-21	Silty clay loam	CL, CH	A-7	0	100	100	100	95-100	45-55	20-30
	21-27	Silty clay loam, silt loam.	CH, CL	A-7	0	100	100	100	95-100	45-55	25-35
	27-60	Loam----------	CL	A-6	0-5	90-95	85-90	75-85	55-65	25-35	10-20
382B---------- Blooming	0-9	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	90-95	60-85	25-40	5-20
	9-21	Silt loam, silty clay loam, loam.	CL	A-6, A-7	0	100	100	90-95	70-95	35-45	15-25
	21-48	Sandy clay loam, loam, clay loam.	CL, CL-ML, SC, SM-SC	A-6, A-4, A-7	0-2	95-100	90-100	70-90	40-80	25-45	5-20
	48-60	Loam, sandy loam, fine sandy loam.	CL, ML, SC, SM	A-4, A-6	0-2	95-100	90-100	60-90	40-75	25-40	3-15
408---------- Waxon	0-28	Silty clay loam	CL	A-7	0-10	95-100	85-100	85-100	80-95	40-50	15-25
	28-37	Loam, sandy loam, clay loam.	CL, ML, SC, SM	A-7, A-6	0-10	95-100	70-100	65-95	40-85	30-50	10-20
	37	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
409B, 409C------- Etter	0-7	Fine sandy loam	ML, SM	A-4	0-1	95-100	95-100	70-95	40-55	17-35	NP-10
	7-21	Loam, sandy loam, fine sandy loam.	ML, SM	A-4	0-2	95-100	95-100	80-90	45-75	20-35	3-10
	21-60	Sand, fine sand	SP-SM, SM	A-3, A-2, A-1	2-15	85-100	50-100	30-85	5-15	<20	NP

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

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	
411A, 411B, 411C--	0-13	Silt loam--------	ML	A-4	0	95-100	95-100	95-100	85-95	25-40	3-10
Waukegan	13-28	Silt loam, loam	CL-ML, CL	A-4, A-6	0	95-100	95-100	95-100	85-95	25-40	5-15
	28-60	Gravelly coarse sand, gravelly sand.	SP, SW, SP-SM	A-1	0-2	80-95	65-85	30-50	3-10	---	NP
414----------	0-16	Silt loam--------	ML, CL	A-6, A-4	0	100	97-100	85-98	60-85	25-40	8-16
Hamel	16-40	Clay loam, loam, silty clay loam.	CH, CL	A-7	0	98-100	95-100	85-95	65-80	40-55	25-35
	40-60	Loam, clay loam	CL	A-6, A-7	0-5	98-100	95-100	80-95	60-80	30-45	10-25
415A, 415B, 415C--	0-9	Loam----------	ML, CL, CL-ML	A-4, A-6	0	95-100	90-100	80-95	60-85	20-40	3-15
Kanaranzi	9-19	Loam, clay loam	CL, ML	A-4, A-6	0	95-100	90-100	80-95	60-85	20-40	3-15
	19-60	Gravelly coarse sand.	SP, SP-SM, GP, GP-GM	A-1, A-2	0-5	50-90	40-85	20-50	0-15	<25	NP-5
449B----------	0-9	Silt loam--------	CL-ML, CL, ML	A-4, A-6	0	100	100	85-100	70-100	19-32	3-13
Crystal Lake	9-40	Silt loam, silty clay loam.	CL	A-6, A-4	0	100	100	90-100	85-100	25-40	9-18
	40-60	Silt loam, silt	CL, CL-ML, ML	A-4, A-6	0	100	100	85-100	75-100	19-32	3-13
454B, 454C, 454E-	0-5	Loamy sand-------	SM, SM-SC	A-2, A-1	0-1	95-100	60-90	40-70	15-30	<20	NP-4
Mahtomedi	5-35	Sand, coarse sand, gravelly sand.	SP-SM, SM	A-2, A-3, A-1	0-15	70-95	50-90	30-70	5-15	<20	NP
	35-60	Sand, coarse sand, gravelly sand.	SP, SM, SP-SM	A-2, A-3, A-1	0-5	75-95	50-90	30-70	2-15	<20	NP
463----------	0-8	Loam----------	ML, CL, CL-ML	A-4	0	100	95-100	70-90	50-75	20-35	3-10
Minneiska	8-60	Stratified silt loam to sand.	SM, ML	A-4	0	100	85-100	50-90	35-60	20-30	NP-5
465----------	0-42	Sandy loam-------	SM	A-4	0	95-100	90-100	60-85	35-50	<25	NP-4
Kalmarville	42-60	Coarse sand, sand, loamy fine sand.	SP, SM, SW, SP-SM	A-3, A-2, A-1	0-2	90-100	85-100	40-80	2-30	<25	NP
495----------	0-18	Fine sandy loam	SM	A-4	0	100	95-100	70-95	35-50	<20	NP
Zumbro	18-56	Loamy sand, loamy fine sand.	SM	A-2	0	100	95-100	60-95	15-30	<20	NP
	56-60	Sand, fine sand, loamy sand.	SP, SM, SP-SM	A-2, A-3	0	95-100	85-100	60-95	4-30	<20	NP
522----------	0-5	Sapric material	Pt	A-8	0	---	---	---	---	---	---
Boots	5-60	Hemic material---	Pt	A-8	0	---	---	---	---	---	---
539----------	0-45	Sapric material	Pt	---	---	---	---	---	---	---	---
Palms	45-60	Clay loam, silty clay loam, fine sandy loam.	CL-ML, CL	A-4, A-6	0	85-100	80-100	70-95	50-90	25-40	5-20
540----------	0-60	Sapric material	Pt	A-8	0	---	---	---	---	---	---
Seelyeville											
545----------	0-45	Sapric material	Pt	A-8	0	---	---	---	---	---	NP
Rondeau	45-60	Marl----------	OH, MH	A-8, A-5, A-7	0	100	95-100	80-90	60-80	50-90	NP-20
611C, 611D-------	0-11	Coarse sandy loam	SM	A-2	0-5	85-100	80-95	50-65	25-35	<20	NP-4
Hawick	11-21	Gravelly loamy coarse sand, gravelly coarse sand, loamy sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	60-95	35-70	5-25	---	NP
	21-60	Gravelly coarse sand, coarse sand, sand.	SP, SP-SM	A-1, A-3	0-5	60-95	50-95	30-65	2-10	---	NP

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

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	
611E, 611F--------	0-9	Loamy sand--------	SM, SP-SM	A-1, A-2	0-5	85-100	80-95	40-70	10-25	---	NP
Hawick	9-21	Gravelly loamy coarse sand, gravelly coarse sand, loamy sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	60-95	35-70	5-25	---	NP
	21-60	Gravelly coarse sand, coarse sand, sand.	SP, SP-SM	A-1, A-3	0-5	60-95	50-95	30-65	2-10	---	NP
857A*, 857B*:											
Urban land.											
Waukegan--------	0-13	Silt loam--------	ML	A-4	0	95-100	95-100	95-100	85-95	25-40	3-10
	13-28	Silt loam, loam	CL-ML, CL	A-4, A-6	0	95-100	95-100	95-100	85-95	25-40	5-15
	28-60	Gravelly coarse sand, gravelly sand.	SP, SW, SP-SM	A-1	0-2	80-95	65-85	30-50	3-10	---	NP
858C*:											
Urban land.											
Chetek----------	0-7	Sandy loam--------	SM, SM-SC	A-2, A-4	0-15	80-100	75-100	45-70	25-40	<23	2-6
	7-14	Loam, sandy loam, gravelly sandy loam.	ML, CL, SM, SC	A-2, A-4, A-6, A-1	0-15	80-100	70-100	45-95	20-75	21-31	3-13
	14-60	Stratified sand to gravel.	SP, SP-SM	A-1	0-15	55-95	50-80	15-50	1-5	---	NP
860C*:											
Urban land.											
Lester----------	0-6	Loam----------	ML, CL	A-6, A-4	0	95-100	90-100	80-95	50-70	30-40	5-15
	6-38	Clay loam, loam	CL	A-7, A-6	0-5	95-100	90-100	80-95	55-75	35-50	15-25
	38-60	Loam, clay loam	CL, CL-ML	A-6, A-4	0-5	95-100	90-100	75-90	50-70	20-40	5-20
861C*, 861E*:											
Urban land.											
Kingsley--------	0-12	Sandy loam--------	SM	A-2, A-4	0-5	90-100	75-100	50-85	30-45	<20	NP
	12-38	Sandy loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4	0-5	90-100	75-95	50-75	25-45	10-20	3-8
	38-60	Sandy loam, coarse sandy loam.	SM, SM-SC	A-2, A-4	0-5	90-100	75-95	50-75	25-40	10-20	2-7
865B*:											
Urban land.											
Hubbard---------	0-16	Loamy sand--------	SM, SP-SM	A-2	0	98-100	95-100	50-80	10-25	<20	NP
	16-38	Sand, coarse sand, loamy sand.	SP-SM, SW-SM	A-1, A-3, A-2-4	0	98-100	70-100	25-75	5-12	<20	NP
	38-60	Sand, coarse sand	SP, SW	A-1, A-3	0	95-100	70-100	20-70	2-5	<20	NP
880F*:											
Brodale---------	0-6	Flaggy loam------	SM, SP-SM, SC, GM	A-2, A-1	7-30	30-65	20-55	15-45	8-35	12-30	NP-8
	6-10	Flaggy very fine sandy loam, flaggy silt loam, cobbly sandy loam.	SM, SC, GM, GC	A-2, A-4, A-1, A-6	20-50	30-65	20-55	15-45	12-45	10-35	NP-12
	10-47	Flaggy very fine sandy loam, flaggy silt loam, cobbly sandy loam.	SM, SC, SM-SC, GM	A-2, A-1	20-50	45-80	40-75	25-50	10-35	12-30	NP-8
	47	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

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	
880F*:											
Rock outcrop.											
888B*, 888C*, 888D*:											
Kingsley	0-12	Sandy loam	SM	A-2, A-4	0-5	90-100	75-100	50-85	30-45	<20	NP
	12-38	Sandy loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4	0-5	90-100	75-95	50-75	25-45	10-20	3-8
	38-60	Sandy loam, coarse sandy loam.	SM, SM-SC	A-2, A-4	0-5	90-100	75-95	50-75	25-40	10-20	2-7
Lester	0-6	Loam	ML, CL	A-6, A-4	0	95-100	90-100	80-95	50-70	30-40	5-15
	6-38	Clay loam, loam	CL	A-7, A-6	0-5	95-100	90-100	80-95	55-75	35-50	15-25
	38-60	Loam, clay loam	CL, CL-ML	A-6, A-4	0-5	95-100	90-100	75-90	50-70	20-40	5-20
889B*, 889C*, 889D*:											
Wadena	0-12	Loam	ML	A-4	0	95-100	80-100	75-95	50-65	25-40	2-10
	12-31	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
	31-60	Sand and gravel	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	45-100	40-95	10-80	2-10	---	NP
Hawick	0-11	Coarse sandy loam	SM	A-2	0-5	85-100	80-95	50-65	25-35	<20	NP-4
	11-21	Gravelly loamy coarse sand, gravelly coarse sand, loamy sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	60-95	35-70	5-25	---	NP
	21-60	Gravelly coarse sand, coarse sand, sand.	SP, SP-SM	A-1, A-3	0-5	60-95	50-95	30-65	2-10	---	NP
895B*, 895C*:											
Kingsley	0-12	Sandy loam	SM	A-2, A-4	0-5	90-100	75-100	50-85	30-45	<20	NP
	12-38	Sandy loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4	0-5	90-100	75-95	50-75	25-45	10-20	3-8
	38-60	Sandy loam, coarse sandy loam.	SM, SM-SC	A-2, A-4	0-5	90-100	75-95	50-75	25-40	10-20	2-7
Mahtomedi	0-5	Loamy sand	SM, SM-SC	A-2, A-1	0-1	95-100	60-90	40-70	15-30	<20	NP-4
	5-35	Sand, coarse sand, gravelly sand.	SP-SM, SM	A-2, A-3, A-1	0-15	70-95	50-90	30-70	5-15	<20	NP
	35-60	Sand, coarse sand, gravelly sand.	SP, SM, SP-SM	A-2, A-3, A-1	0-5	75-95	50-90	30-70	2-15	<20	NP
Spencer	0-13	Silt loam	ML, CL, CL-ML	A-4	0	100	100	90-100	70-90	20-28	3-9
	13-45	Silt loam, silty clay loam.	CL	A-6	0	100	100	90-100	80-100	25-40	10-20
	45-60	Sandy loam, loam, gravelly sandy loam.	SM, SC, ML, CL	A-2, A-4, A-1, A-6	0-4	60-100	55-90	30-85	15-65	<30	NP-14
896E*, 896F*:											
Kingsley	0-12	Sandy loam	SM	A-2, A-4	0-5	90-100	75-100	50-85	30-45	<20	NP
	12-38	Sandy loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4	0-5	90-100	75-95	50-75	25-45	10-20	3-8
	38-60	Sandy loam, coarse sandy loam.	SM, SM-SC	A-2, A-4	0-5	90-100	75-95	50-75	25-40	10-20	2-7

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

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	
896E*, 896F*:											
Mahtomedi-------	0-5	Loamy sand-------	SM, SM-SC	A-2, A-1	0-1	95-100	60-90	40-70	15-30	<20	NP-4
	5-35	Sand, coarse sand, gravelly sand.	SP-SM, SM	A-2, A-3, A-1	0-15	70-95	50-90	30-70	5-15	<20	NP
	35-60	Sand, coarse sand, gravelly sand.	SP, SM, SP-SM	A-2, A-3, A-1	0-5	75-95	50-90	30-70	2-15	<20	NP
963C2*, 963D2*, 963E2*:											
Timula---------	0-60	Silt loam--------	ML, CL-ML	A-4	0	100	100	95-100	85-100	26-35	5-10
Bold-----------	0-60	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	100	90-100	20-35	3-15
	7-60	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	100	90-100	20-35	3-15
1013*. Pits											
1027*. Udorthents											
1029*. Pits											
1039*. Urban land											
1055*: Aquolls.											
Histosols.											
1072*. Udorthents											
1815-------------	0-18	Loamy fine sand	SM	A-2	0	100	95-100	60-95	15-35	<20	NP
Zumbro	18-56	Loamy sand, loamy fine sand.	SM	A-2	0	100	95-100	60-95	15-30	<20	NP
	56-60	Sand, fine sand, loamy sand.	SP, SM, SP-SM	A-2, A-3	0	95-100	85-100	60-95	4-30	<20	NP
1816-------------	0-37	Silt loam--------	CL	A-6, A-7	0	100	100	95-100	90-100	25-45	10-20
Kennebec Variant	37-60	Silt loam, silty clay loam.	CL, CL-ML	A-6, A-4	0	100	100	95-100	90-100	25-40	5-15
1821-------------	0-12	Sandy loam-------	SM	A-2-4, A-4	0	100	100	60-80	30-50	---	NP
Algansee	12-60	Stratified sand to loam.	SM, SP-SM	A-3, A-2-4	0	100	100	50-70	5-15	---	NP
1824-------------	0-12	Silt loam--------	OL, ML	A-7, A-4, A-6, A-5	0	100	100	80-100	70-95	30-50	5-20
Quam	12-45	Silty clay loam, silt loam, loam.	CL, ML	A-7, A-6, A-4	0	100	100	80-100	70-95	30-50	5-25
	45-60	Clay loam, silty clay loam, silt loam.	CL, ML, CL-ML	A-4, A-6, A-7	0	100	90-100	85-95	70-90	20-50	5-20
1825C------------	0-60	Sapric material	Pt	A-8	0	---	---	---	---	---	---
Seelyeville											
1827A, 1827B, 1827C----------	0-36	Silt loam--------	ML, CL	A-4, A-6	0	95-100	95-100	95-100	85-95	25-40	3-15
Waukegan	36-40	Sand, fine sand, gravelly sand.	SP, SP-SM	A-1, A-3, A-2	0-2	80-95	65-85	30-60	3-10	---	NP
	40	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 14.--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	
1848B----------	0-10	Loamy sand-------	SM	A-2	0	100	100	50-75	15-25	---	NP
Sparta	10-25	Fine sand, sand	SM, SP-SM	A-2	0	100	100	55-75	10-25	---	NP
	25-42	Clay loam, clay	CL, CH	A-7	0-2	90-100	80-95	80-90	60-75	40-60	20-30
	42	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
1894B----------	0-15	Loam-------------	ML, CL	A-6, A-4	0	100	95-100	95-100	90-100	30-40	5-15
Winnebago	15-40	Clay loam, sandy clay loam, loam.	SC, CL, GC	A-6, A-2	0-5	70-95	60-90	45-80	30-60	28-40	12-22
	40-60	Sandy loam, loam	SC, GM-GC, SM-SC, CL	A-2, A-6, A-4	0-10	60-80	60-80	35-60	30-55	14-37	4-22
1895B----------	0-13	Loam-------------	SM-SC, SC	A-6, A-4	0-5	90-100	90-100	55-70	35-45	15-35	5-15
Carmi	13-25	Gravelly sandy clay loam, gravelly sandy loam.	SM-SC, SC, GC, GM-GC	A-2, A-4, A-6	0-5	65-95	60-90	50-65	20-40	15-35	5-15
	25-60	Stratified loamy sand to coarse sand.	SP-SM, GP-GM, SM, GM	A-1	0-15	40-65	35-65	20-50	5-25	<20	NP-5
1896B*:											
Ostrander-------	0-17	Loam-------------	CL-ML, CL	A-4, A-6	0	100	98-100	90-95	70-90	25-40	5-15
	17-53	Loam, sandy clay loam, sandy loam.	CL, SC	A-6	0-2	95-100	75-98	65-90	45-65	25-35	10-15
	53-60	Loam-------------	CL	A-6	0-1	95-100	90-98	80-95	50-75	25-40	10-20
Carmi----------	0-13	Loam-------------	SM-SC, SC	A-6, A-4	0-5	90-100	90-100	55-70	35-45	15-35	5-15
	13-25	Gravelly sandy clay loam, gravelly sandy loam.	SM-SC, SC, GC, GM-GC	A-2, A-4, A-6	0-5	65-95	60-90	50-65	20-40	15-35	5-15
	25-60	Stratified loamy sand to coarse sand.	SP-SM, GP-GM, SM, GM	A-1	0-15	40-65	35-65	20-50	5-25	<20	NP-5
1898F*:											
Etter----------	0-7	Fine sandy loam	ML, SM	A-4	0-1	95-100	95-100	70-95	40-55	17-35	NP-10
	7-21	Loam, sandy loam, fine sandy loam.	ML, SM	A-4	0-2	95-100	95-100	80-90	45-75	20-35	3-10
	21-60	Sand, fine sand	SP-SM, SM	A-3, A-2, A-1	2-15	85-100	50-100	30-85	5-15	<20	NP
Brodale---------	0-6	Flaggy loam------	SM, SP-SM, SC, GM	A-2, A-1	7-30	30-65	20-55	15-45	8-35	12-30	NP-8
	6-10	Flaggy very fine sandy loam, flaggy silt loam, cobbly sandy loam.	SM, SC, GM, GC	A-2, A-4, A-1, A-6	20-50	30-65	20-55	15-45	12-45	10-35	NP-12
	10-47	Flaggy very fine sandy loam, flaggy silt loam, cobbly sandy loam.	SM, SC, SM-SC, GM	A-2, A-1	20-50	45-80	40-75	25-50	10-35	12-30	NP-8
	47	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
1902B----------	0-13	Silt loam--------	ML, CL, CL-ML	A-4	0	100	100	90-100	70-90	20-30	3-10
Jewett	13-24	Loam, silt loam	CL	A-6	0-10	100	85-95	75-100	50-90	25-40	10-20
	24-33	Sandy loam, loam	CL, SC, CL-ML, SM-SC	A-4, A-6	0-10	85-100	85-95	75-85	40-65	20-35	5-20
	33-60	Sandy loam-------	SM, SM-SC	A-2	0-15	85-100	85-95	65-80	25-35	<20	2-7

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--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	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	G/cm^3	In/hr	In/in	pH					Pct
2B, 2C----------	0-17	18-27	1.45-1.55	0.6-2.0	0.20-0.24	5.6-7.3	Low----------	0.28	5	6	3-5
Ostrander	17-53	13-27	1.45-1.65	0.6-2.0	0.17-0.19	5.1-7.3	Low----------	0.28			
	53-60	18-27	1.60-1.80	0.6-2.0	0.17-0.19	6.6-7.8	Low----------	0.37			
7A, 7B, 7C, 7D---	0-16	4-10	1.45-1.60	6.0-20	0.08-0.12	5.1-7.3	Low----------	0.15	5	2	2-5
Hubbard	16-38	1-5	1.55-1.65	6.0-20	0.03-0.07	5.1-7.3	Low----------	0.15			
	38-60	0-5	1.55-1.65	6.0-20	0.03-0.07	6.1-7.3	Low----------	0.15			
8A, 8B----------	0-25	3-10	1.20-1.40	2.0-6.0	0.09-0.12	5.1-7.3	Low----------	0.17	5	2	1-2
Sparta	25-60	1-8	1.40-1.60	6.0-20	0.05-0.11	5.1-6.5	Low----------	0.17			
12C---------------	0-4	5-10	1.45-1.55	6.0-20	0.10-0.13	5.1-6.5	Low----------	0.15	2	8	.5-1
Emmert	4-60	1-3	1.55-1.65	>20	0.02-0.04	5.1-7.3	Low----------	0.15			
27A, 27B---------	0-16	12-18	1.50-1.55	2.0-6.0	0.12-0.15	5.6-7.3	Low----------	0.20	4	3	1-2
Dickinson	16-36	10-15	1.45-1.55	2.0-6.0	0.12-0.15	5.1-6.5	Low----------	0.20			
	36-60	5-10	1.60-1.70	6.0-20	0.02-0.04	5.6-6.5	Low----------	0.15			
39A, 39B---------	0-12	18-30	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	4	5	3-6
Wadena	12-31	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	Low----------	0.32			
	31-60	1-5	1.55-1.65	>6.0	0.02-0.04	6.6-8.4	Low----------	0.10			
39B2--------------	0-9	18-30	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	4	5	3-6
Wadena	9-31	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	Low----------	0.32			
	31-60	1-5	1.55-1.65	>6.0	0.02-0.04	6.6-8.4	Low----------	0.10			
39C---------------	0-12	18-30	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	4	5	3-6
Wadena	12-31	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	Low----------	0.32			
	31-60	1-5	1.55-1.65	>6.0	0.02-0.04	6.6-8.4	Low----------	0.10			
39C2--------------	0-9	18-30	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	4	5	3-6
Wadena	9-31	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	Low----------	0.32			
	31-60	1-5	1.55-1.65	>6.0	0.02-0.04	6.6-8.4	Low----------	0.10			
39D---------------	0-12	18-30	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	4	5	3-6
Wadena	12-31	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	Low----------	0.32			
	31-60	1-5	1.55-1.65	>6.0	0.02-0.04	6.6-8.4	Low----------	0.10			
41A, 41B---------	0-13	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	Low----------	0.20	3	3	2-4
Estherville	13-21	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	Low----------	0.20			
	21-60	0-8	1.50-1.65	6.0-20	0.02-0.04	6.6-8.4	Low----------	0.10			
42C---------------	0-8	5-15	1.35-1.45	2.0-6.0	0.10-0.12	6.1-8.4	Low----------	0.10	3	8	.5-1
Salida	8-14	2-8	1.50-1.65	>20	0.02-0.04	7.4-8.4	Low----------	0.10			
	14-60	0-5	1.50-1.65	>20	0.02-0.04	7.4-8.4	Low----------	0.10			
49B---------------	0-8	8-15	1.35-1.55	0.6-2.0	0.22-0.28	5.1-6.5	Low----------	0.37	4	5	2-4
Antigo	8-24	18-30	1.55-1.65	0.6-2.0	0.18-0.22	5.1-6.5	Moderate-----	0.37			
	24-60	1-6	1.75-2.20	>6.0	0.02-0.06	5.1-6.5	Low----------	0.10			
81B, 81C, 81E----	0-8	2-6	1.55-1.65	6.0-20	0.10-0.13	5.1-6.5	Low----------	0.15	4	2	<1
Boone	8-24	0-3	1.55-1.70	6.0-20	0.04-0.11	5.1-6.5	Low----------	0.15			
	24-60	---	---	---	---	---	----------	----			
94C---------------	0-60	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	5	6	4-5
Terril											
98----------------	0-20	20-26	1.25-1.30	0.6-2.0	0.22-0.24	6.6-7.3	Moderate-----	0.28	5	6	3-5
Colo	20-60	30-35	1.35-1.45	0.6-2.0	0.18-0.20	6.1-7.3	High----------	0.28			
100A, 100B, 100C-	0-6	14-20	1.30-1.45	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.28	2	5	2-5
Copaston	6-15	14-20	1.40-1.60	0.6-6.0	0.15-0.17	5.6-7.3	Low----------	0.28			
	15	---	---	---	---	---	----------	----			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	G/cm³	In/hr	In/in	pH					Pct
106B, 106C, 106C2, 106D2---- Lester	0-6	15-27	1.30-1.40	0.6-2.0	0.20-0.22	5.6-6.5	Low----------	0.28	5	6	2-4
	6-38	20-35	1.45-1.55	0.6-2.0	0.15-0.19	5.1-6.5	Moderate-----	0.28			
	38-60	20-30	1.55-1.75	0.6-2.0	0.14-0.19	6.6-7.8	Low----------	0.37			
109---------- Cordova	0-10	15-30	1.25-1.45	0.2-2.0	0.18-0.22	6.1-7.3	Moderate-----	0.28	5	6	4-7
	10-20	28-35	1.35-1.50	0.2-0.6	0.15-0.19	5.1-6.5	Moderate-----	0.28			
	20-60	18-30	1.45-1.70	0.6-2.0	0.14-0.16	7.4-8.4	Moderate-----	0.28			
113---------- Webster	0-14	26-36	1.35-1.40	0.6-2.0	0.19-0.21	6.6-7.3	Moderate-----	0.24	5	6	6-7
	14-30	25-35	1.40-1.50	0.6-2.0	0.16-0.18	6.6-7.8	Moderate-----	0.32			
	30-60	18-29	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	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	Moderate-----	0.28	5	6	5-10
	26-38	25-35	1.35-1.50	0.2-2.0	0.15-0.19	6.6-7.8	Moderate-----	0.28			
	38-60	22-32	1.35-1.50	0.6-2.0	0.15-0.19	7.4-7.8	Moderate-----	0.28			
129---------- Cylinder	0-12	22-32	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.24	4	6	4-5
	12-25	22-30	1.45-1.60	0.6-2.0	0.17-0.19	6.1-7.3	Moderate-----	0.32			
	25-60	2-12	1.60-1.70	>20	0.02-0.04	7.4-8.4	Low----------	0.10			
150B---------- Spencer	0-13	9-17	1.40-1.55	0.6-2.0	0.22-0.24	5.6-7.3	Low----------	0.37	5	5	2-4
	13-45	18-30	1.50-1.65	0.6-2.0	0.18-0.22	5.1-5.5	Moderate-----	0.37			
	45-60	10-20	1.80-2.00	0.6-2.0	0.08-0.18	5.6-6.5	Low----------	0.28			
151C, 151D---------- Burkhardt	0-12	5-12	1.35-1.55	2.0-6.0	0.13-0.15	5.1-6.5	Low----------	0.20	3	3	2-4
	12-22	8-18	1.55-1.65	2.0-6.0	0.11-0.19	5.1-6.5	Low----------	0.20			
	22-60	1-6	1.50-1.60	>6.0	0.02-0.04	5.6-6.5	Low----------	0.10			
155B, 155C, 155E---------- Chetek	0-7	5-12	1.35-1.70	2.0-6.0	0.11-0.15	5.1-6.5	Low----------	0.24	3	3	2-3
	7-14	10-18	1.65-1.75	2.0-6.0	0.10-0.19	5.1-6.5	Low----------	0.24			
	14-60	1-6	1.50-1.60	>6.0	0.02-0.04	5.1-6.5	Low----------	0.10			
173F---------- Frontenac	0-11	18-27	1.35-1.45	0.6-2.0	0.20-0.24	5.6-7.3	Moderate-----	0.32	4	3	2-5
	11-24	18-27	1.40-1.50	0.6-2.0	0.17-0.22	5.6-7.3	Moderate-----	0.32			
	24-60	5-10	1.45-1.70	2.0-6.0	0.04-0.10	6.6-7.8	Low----------	0.24			
176---------- Garwin	0-14	30-35	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	High---------	0.28	5	7	6-7
	14-28	28-34	1.28-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High---------	0.28			
	28-60	20-26	1.35-1.45	0.6-2.0	0.20-0.22	6.6-7.8	Moderate-----	0.28			
177A, 177B---------- Gotham	0-9	2-4	1.35-1.55	2.0-6.0	0.10-0.12	5.6-7.3	Low----------	0.17	5	2	.5-2
	9-48	2-4	1.40-1.60	6.0-20	0.06-0.11	5.1-7.3	Low----------	0.17			
	48-60	1-3	1.50-1.70	6.0-20	0.05-0.10	5.1-7.3	Low----------	0.17			
177C---------- Gotham	0-9	2-4	1.35-1.55	2.0-6.0	0.10-0.12	5.6-7.3	Low----------	0.17	5	2	.5-2
	9-48	2-4	1.40-1.60	6.0-20	0.06-0.11	5.1-7.3	Low----------	0.17			
	38-60	1-3	1.50-1.70	6.0-20	0.05-0.10	5.1-7.3	Low----------	0.17			
189---------- Auburndale	0-13	6-25	1.35-1.55	0.6-2.0	0.22-0.24	5.1-6.0	Low----------	0.37	5	5	4-12
	13-58	18-22	1.50-1.65	0.2-2.0	0.20-0.22	5.1-6.0	Moderate-----	0.37			
	58-60	5-15	1.75-1.85	0.6-2.0	0.08-0.19	5.6-6.5	Low----------	0.28			
203B---------- Joy	0-23	15-25	1.10-1.20	0.6-2.0	0.22-0.24	5.6-7.3	Low----------	0.28	5	6	2-4
	23-55	18-27	1.15-1.25	0.6-2.0	0.20-0.22	5.1-6.5	Low----------	0.43			
	55-60	12-23	1.15-1.30	0.6-2.0	0.20-0.22	6.1-7.8	Low----------	0.43			
208---------- Kato	0-23	24-35	1.25-1.40	0.6-2.0	0.18-0.24	6.1-7.8	Moderate-----	0.28	4	6	5-8
	23-30	24-35	1.30-1.40	0.6-2.0	0.18-0.22	5.1-7.3	Moderate-----	0.28			
	30-60	<5	1.55-1.65	6.0-20	0.02-0.07	6.1-7.8	Low----------	0.15			
213B---------- Klinger	0-13	26-30	1.30-1.35	0.6-2.0	0.22-0.24	5.1-7.3	Moderate-----	0.32	5	6	5-6
	13-28	28-35	1.35-1.45	0.6-2.0	0.18-0.20	5.1-6.5	Moderate-----	0.43			
	28-60	20-28	1.65-1.80	0.6-2.0	0.17-0.19	5.6-7.8	Low----------	0.43			
226---------- Lawson	0-30	10-20	1.20-1.55	0.6-2.0	0.22-0.24	6.1-7.8	Low----------	0.32	5	5	3-5
	30-60	18-30	1.55-1.65	0.6-2.0	0.18-0.20	6.1-7.8	Moderate-----	0.43			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	G/cm³	In/hr	In/in	pH					Pct
239	0-10	20-27	1.30-1.40	0.6-2.0	0.20-0.24	5.6-7.3	Low	0.24	5	6	2-4
Le Sueur	10-53	24-35	1.30-1.45	0.6-2.0	0.15-0.19	5.1-6.5	Moderate	0.32			
	53-60	20-27	1.50-1.65	0.6-2.0	0.15-0.19	7.4-8.4	Moderate	0.32			
250	0-41	22-30	1.25-1.35	0.6-2.0	0.22-0.24	5.6-7.3	Moderate	0.32	5	6	5-6
Kennebec	41-60	24-28	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Moderate	0.43			
251D, 251E	0-11	18-24	1.40-1.45	0.6-2.0	0.20-0.22	6.1-7.3	Low	0.24	2	6	2-3
Marlean	11-42	18-30	1.40-1.55	0.6-2.0	0.18-0.22	6.1-7.3	Moderate	0.24			
	42	12-28	1.70-1.90	2.0-6.0	0.08-0.15	7.4-7.8	Low	0.24			
252	0-14	27-35	1.30-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Moderate	0.28	4	7	4-8
Marshan	14-32	18-30	1.45-1.55	0.6-2.0	0.15-0.19	5.6-7.3	Low	0.28			
	32-60	<5	1.55-1.65	6.0-20	0.02-0.05	6.1-7.3	Low	0.15			
253	0-17	28-32	1.30-1.45	0.6-2.0	0.18-0.22	6.1-7.3	High	0.28	5	7	6-8
Maxcreek	17-30	25-32	1.40-1.55	0.6-2.0	0.20-0.22	6.1-7.3	High	0.28			
	30-60	18-30	1.45-1.60	0.6-2.0	0.17-0.19	6.6-7.8	Moderate	0.28			
255	0-17	18-27	1.25-1.35	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	4	4L	4-8
Mayer	17-31	18-27	1.25-1.35	0.6-2.0	0.16-0.19	7.4-8.4	Low	0.28			
	31-60	1-5	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low	0.15			
279B, 279C	0-11	9-15	1.40-1.55	0.6-2.0	0.22-0.24	5.6-7.3	Low	0.37	5	5	2-4
Otterholt	11-35	18-25	1.50-1.65	0.6-2.0	0.20-0.22	5.1-5.5	Moderate	0.37			
	35-60	10-20	1.80-2.00	0.6-2.0	0.08-0.18	5.6-6.5	Low	0.28			
283A, 283B, 283D-	0-14	3-15	1.35-1.65	2.0-6.0	0.09-0.12	5.1-7.3	Low	0.17	5	2	<1
Plainfield	14-60	1-4	1.50-1.75	6.0-20	0.04-0.07	5.1-6.5	Low	0.17			
285A, 285B, 285C-	0-19	18-27	1.10-1.20	0.6-2.0	0.22-0.24	5.6-7.3	Low	0.32	5-4	6	2-4
Port Byron	19-60	15-27	1.15-1.30	0.6-2.0	0.20-0.22	5.6-8.4	Low	0.43			
299A, 299B, 299C-	0-16	18-28	1.30-1.40	0.6-2.0	0.20-0.22	5.1-6.5	Low	0.28	4	6	2-6
Rockton	16-35	25-35	1.40-1.55	0.6-2.0	0.17-0.19	5.1-6.5	Moderate	0.28			
	35	---	---	---	---	---	---	---			
301B	0-34	18-24	1.20-1.30	0.6-2.0	0.22-0.26	5.6-7.3	Low	0.32	5	5	3-5
Lindstrom	34-60	12-20	1.40-1.50	0.6-2.0	0.17-0.19	6.6-7.8	Low	0.43			
313	0-48	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate	0.28	5	6	4-6
Spillville	48-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	Low	0.28			
317	0-37	28-35	1.15-1.30	0.2-0.6	0.18-0.22	7.4-7.8	Moderate	0.28	5	8	4-10
Oshawa	37-60	18-35	1.30-1.35	0.2-0.6	0.17-0.19	7.4-7.8	Low	0.28			
318	0-19	18-27	1.25-1.35	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	4	4L	4-8
Mayer	19-36	18-27	1.25-1.35	0.6-2.0	0.16-0.19	7.4-8.4	Low	0.28			
	36-60	1-5	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low	0.15			
320B, 320C2	0-9	10-18	1.10-1.30	0.6-2.0	0.22-0.24	6.6-7.8	Low	0.32	5	5	2-3
Tallula	9-27	12-18	1.10-1.30	0.6-2.0	0.20-0.22	6.6-7.8	Low	0.43			
	27-60	8-18	1.10-1.30	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.43			
342B, 342C, 342E, 342F	0-12	3-10	1.40-1.60	0.6-2.0	0.10-0.18	5.6-6.5	Low	0.20	5	3	2-4
Kingsley	12-38	6-18	1.70-1.82	0.2-0.6	0.13-0.16	5.1-7.3	Low	0.20			
	38-60	5-10	1.75-1.85	0.2-0.6	0.11-0.14	5.6-7.8	Low	0.28			
344	0-12	22-27	1.00-1.40	0.6-2.0	0.22-0.24	5.1-6.5	Low	0.28	5	6	6-15
Quam	12-45	22-35	1.25-1.45	0.2-0.6	0.16-0.22	5.1-6.5	Moderate	0.28			
	45-60	20-35	1.40-1.65	0.2-0.6	0.14-0.19	5.1-6.5	Moderate	0.37			
377B	0-15	18-27	1.30-1.45	0.6-2.0	0.22-0.24	5.6-7.3	Low	0.32	5	6	4-6
Merton	15-37	18-30	1.35-1.50	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.32			
	37-60	18-27	1.50-1.75	0.6-2.0	0.17-0.19	5.6-7.8	Low	0.32			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	G/cm³	In/hr	In/in	pH					Pct
378----------	0-21	30-35	1.35-1.40	0.6-2.0	0.21-0.23	6.6-7.3	High----------	0.24	5	6	6-7
Maxfield	21-27	25-34	1.40-1.50	0.6-2.0	0.18-0.20	6.1-7.3	High----------	0.32			
	27-60	20-26	1.65-1.85	0.6-2.0	0.17-0.19	6.1-7.8	Low----------	0.32			
382B----------	0-9	18-27	1.30-1.45	0.6-2.0	0.24-0.30	5.6-6.5	Moderate-----	0.32	5	6	2-4
Blooming	9-21	24-32	1.35-1.50	0.6-2.0	0.18-0.22	5.6-6.5	Moderate-----	0.32			
	21-48	20-30	1.50-1.65	0.6-2.0	0.16-0.19	5.1-7.3	Moderate-----	0.32			
	48-60	18-27	1.50-1.75	0.6-2.0	0.17-0.19	6.6-7.8	Low----------	0.32			
408----------	0-28	28-35	1.20-1.40	0.6-2.0	0.17-0.22	6.6-7.8	Moderate-----	0.28	4	6	5-15
Faxon	28-37	18-30	1.40-1.60	0.6-2.0	0.12-0.19	6.6-7.8	Moderate-----	0.28			
	37	---	---	---	---	---	----------	----			
409B, 409C-------	0-7	8-15	1.30-1.50	2.0-6.0	0.16-0.18	5.6-7.3	Low----------	0.20	4	3	1-2
Etter	7-21	10-18	1.35-1.55	0.6-2.0	0.17-0.19	5.1-6.5	Low----------	0.20			
	21-60	1-5	1.50-1.70	6.0-20	0.05-0.07	5.1-6.0	Low----------	0.15			
411A, 411B, 411C-	0-13	18-27	1.35-1.55	0.6-2.0	0.22-0.24	5.6-7.3	Low----------	0.32	4	6	2-5
Waukegan	13-28	18-27	1.35-1.55	0.6-2.0	0.20-0.22	5.1-7.3	Low----------	0.43			
	28-60	1-10	1.50-1.70	6.0-20	0.02-0.04	5.6-7.8	Low----------	0.10			
414----------	0-16	20-27	1.30-1.40	0.6-2.0	0.20-0.24	5.6-7.3	Low----------	0.28	5	6	5-7
Hamel	16-40	24-35	1.45-1.60	0.2-0.6	0.16-0.19	5.6-7.3	Moderate-----	0.28			
	40-60	20-30	1.55-1.75	0.6-2.0	0.14-0.18	7.4-7.8	Moderate-----	0.28			
415A, 415B, 415C-	0-9	18-32	1.30-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.28	4	6	2-5
Kanaranzi	9-19	18-32	1.35-1.50	0.6-2.0	0.17-0.22	5.6-7.8	Low----------	0.28			
	19-60	0-5	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low----------	0.10			
449B----------	0-9	8-20	1.35-1.55	0.6-2.0	0.20-0.24	5.1-6.5	Low----------	0.37	5	5	2-4
Crystal Lake	9-40	18-30	1.50-1.60	0.6-2.0	0.18-0.22	5.1-6.0	Moderate-----	0.37			
	40-60	8-20	1.45-1.55	0.6-2.0	0.20-0.22	5.1-7.3	Low----------	0.37			
454B, 454C, 454E-	0-5	2-15	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.15	5	2	<1
Mahtomedi	5-35	0-10	1.45-1.70	6.0-20	0.05-0.07	5.1-6.5	Low----------	0.10			
	35-60	0-10	1.45-1.75	6.0-20	0.04-0.09	5.1-7.8	Low----------	0.10			
463----------	0-8	10-27	1.30-1.40	2.0-6.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	5	2-5
Minneiska	8-60	5-18	1.40-1.60	2.0-6.0	0.13-0.18	7.4-8.4	Low----------	0.28			
465----------	0-42	8-15	1.35-1.50	2.0-6.0	0.13-0.18	6.6-7.8	Low----------	0.20	5	3	2-4
Kalmarville	42-60	2-5	1.55-1.65	6.0-20	0.06-0.09	6.6-7.8	Low----------	0.10			
495----------	0-18	5-18	1.35-1.45	2.0-6.0	0.13-0.16	5.6-7.8	Low----------	0.17	5	3	2-4
Zumbro	18-56	2-10	1.45-1.55	6.0-20	0.10-0.12	5.6-7.8	Low----------	0.17			
	56-60	0-10	1.45-1.60	6.0-20	0.05-0.12	6.1-7.8	Low----------	0.17			
522----------	0-5	---	0.16-0.45	0.2-6.0	0.35-0.45	6.6-7.8	----------	----	---	3	60-80
Boots	5-60	---	0.16-0.28	0.6-6.0	0.35-0.45	6.6-7.8	----------	----			
539----------	0-45	---	0.25-0.45	0.2-6.0	0.35-0.45	5.1-7.8	----------	----	2	3	>75
Palms	45-60	7-35	1.45-1.75	0.2-2.0	0.14-0.22	6.1-8.4	Low----------	----			
540----------	0-60	---	0.10-0.25	0.2-6.0	0.35-0.45	5.6-7.3	----------	----	---	3	>25
Seelyeville											
545----------	0-45	0-10	0.10-0.25	0.2-6.0	0.35-0.48	5.1-7.8	----------	----	---	2	>25
Rondeau	45-60	5-15	0.05-0.20	<0.2	0.20-0.22	7.4-7.8	----------	----			
611C, 611D-------	0-11	5-15	1.35-1.55	2.0-6.0	0.13-0.15	6.1-7.8	Low----------	0.17	3	3	1-4
Hawick	11-21	1-10	1.50-1.65	>6.0	0.03-0.10	6.1-7.8	Low----------	0.17			
	21-60	1-5	1.55-1.65	>20	0.02-0.06	7.4-8.4	Low----------	0.10			
611E, 611F-------	0-9	2-10	1.40-1.60	6.0-20	0.10-0.12	6.1-7.8	Low----------	0.17	3	2	1-3
Hawick	9-21	1-10	1.50-1.65	>6.0	0.03-0.10	6.1-7.8	Low----------	0.17			
	21-60	1-5	1.55-1.65	>20	0.02-0.06	7.4-8.4	Low----------	0.10			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	G/cm³	In/hr	In/in	pH					Pct
857A*, 857B*:											
Urban land.											
Waukegan--------	0-13	18-27	1.35-1.55	0.6-2.0	0.22-0.24	5.6-7.3	Low----------	0.32	4	6	2-5
	13-28	18-27	1.35-1.55	0.6-2.0	0.20-0.22	5.1-7.3	Low----------	0.43			
	28-60	1-10	1.50-1.70	6.0-20	0.02-0.04	5.6-7.8	Low----------	0.10			
858C*:											
Urban land.											
Chetek----------	0-7	5-12	1.35-1.70	2.0-6.0	0.11-0.15	5.1-6.5	Low----------	0.24	3	3	2-3
	7-14	10-18	1.65-1.75	2.0-6.0	0.10-0.19	5.1-6.5	Low----------	0.24			
	14-60	1-6	1.50-1.60	>6.0	0.02-0.04	5.1-6.5	Low----------	0.10			
860C*:											
Urban land.											
Lester----------	0-6	15-27	1.30-1.40	0.6-2.0	0.20-0.22	5.6-6.5	Low----------	0.28	5	6	2-4
	6-38	20-35	1.45-1.55	0.6-2.0	0.15-0.19	5.1-6.5	Moderate-----	0.28			
	38-60	20-30	1.55-1.75	0.6-2.0	0.14-0.19	6.6-7.8	Low----------	0.37			
861C*, 861E*:											
Urban land.											
Kingsley--------	0-12	3-10	1.40-1.60	0.6-2.0	0.10-0.18	5.6-6.5	Low----------	0.20	5	3	2-4
	12-38	6-18	1.70-1.82	0.2-0.6	0.13-0.16	5.1-7.3	Low----------	0.20			
	38-60	5-10	1.75-1.85	0.2-0.6	0.11-0.14	5.6-7.8	Low----------	0.28			
865B*:											
Urban land.											
Hubbard---------	0-16	4-10	1.45-1.60	6.0-20	0.08-0.12	5.1-7.3	Low----------	0.15	5	2	2-5
	16-38	1-5	1.55-1.65	6.0-20	0.03-0.07	5.1-7.3	Low----------	0.15			
	38-60	0-5	1.55-1.65	6.0-20	0.03-0.07	6.1-7.3	Low----------	0.15			
880F*:											
Brodale---------	0-6	5-18	1.15-1.30	0.6-2.0	0.06-0.12	6.6-8.4	Low----------	0.20	2	8	2-5
	6-10	5-18	1.20-1.35	0.6-2.0	0.06-0.12	6.6-8.4	Low----------	0.20			
	10-47	5-18	1.20-1.35	0.6-6.0	0.04-0.09	7.9-8.4	Low----------	0.20			
	47	---	---	---	---	---	----------	----			
Rock outcrop.											
888B*, 888C*, 888D*:											
Kingsley-------	0-12	3-10	1.40-1.60	0.6-2.0	0.10-0.18	5.6-6.5	Low----------	0.20	5	3	2-4
	12-38	6-18	1.70-1.82	0.2-0.6	0.13-0.16	5.1-7.3	Low----------	0.20			
	38-60	5-10	1.75-1.85	0.2-0.6	0.11-0.14	5.6-7.8	Low----------	0.28			
Lester---------	0-6	15-27	1.30-1.40	0.6-2.0	0.20-0.22	5.6-6.5	Low----------	0.28	5	6	2-4
	6-38	20-35	1.45-1.55	0.6-2.0	0.15-0.19	5.1-6.5	Moderate-----	0.28			
	38-60	20-30	1.55-1.75	0.6-2.0	0.14-0.19	6.6-7.8	Low----------	0.37			
889B*, 889C*, 889D*:											
Wadena---------	0-12	18-30	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	4	5	3-6
	12-31	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	Low----------	0.32			
	31-60	1-5	1.55-1.65	>6.0	0.02-0.04	6.6-8.4	Low----------	0.10			
Hawick---------	0-11	5-15	1.35-1.55	2.0-6.0	0.13-0.15	6.1-7.8	Low----------	0.17	3	3	1-4
	11-21	1-10	1.50-1.65	>6.0	0.03-0.10	6.1-7.8	Low----------	0.17			
	21-60	1-5	1.55-1.65	>20	0.02-0.06	7.4-8.4	Low----------	0.10			
895B*, 895C*:											
Kingsley--------	0-12	3-10	1.40-1.60	0.6-2.0	0.10-0.18	5.6-6.5	Low----------	0.20	5	3	2-4
	12-38	6-18	1.70-1.82	0.2-0.6	0.13-0.16	5.1-7.3	Low----------	0.20			
	38-60	5-10	1.75-1.85	0.2-0.6	0.11-0.14	5.6-7.8	Low----------	0.28			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	G/cm^3	In/hr	In/in	pH					Pct
895B*, 895C*:											
Mahtomedi-------	0-5	2-15	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.15	5	2	<1
	5-35	0-10	1.45-1.70	6.0-20	0.05-0.07	5.1-6.5	Low----------	0.10			
	35-60	0-10	1.45-1.75	6.0-20	0.04-0.09	5.1-7.8	Low----------	0.10			
Spencer---------	0-13	9-17	1.40-1.55	0.6-2.0	0.22-0.24	5.6-7.3	Low----------	0.37	5	5	2-4
	13-45	18-30	1.50-1.65	0.6-2.0	0.18-0.22	5.1-5.5	Moderate-----	0.37			
	45-60	10-20	1.80-2.00	0.6-2.0	0.08-0.18	5.6-6.5	Low----------	0.28			
896E*, 896F*:											
Kingsley--------	0-12	3-10	1.40-1.60	0.6-2.0	0.10-0.18	5.6-6.5	Low----------	0.20	5	3	2-4
	12-38	6-18	1.70-1.82	0.2-0.6	0.13-0.16	5.1-7.3	Low----------	0.20			
	38-60	5-10	1.75-1.85	0.2-0.6	0.11-0.14	5.6-7.8	Low----------	0.28			
Mahtomedi-------	0-5	2-15	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.15	5	2	<1
	5-35	0-10	1.45-1.70	6.0-20	0.05-0.07	5.1-6.5	Low----------	0.10			
	35-60	0-10	1.45-1.75	6.0-20	0.04-0.09	5.1-7.8	Low----------	0.10			
963C2*, 963D2*, 963E2*:											
Timula----------	0-60	10-18	1.30-1.60	0.6-2.0	0.20-0.24	6.1-8.4	Low----------	0.37	5-4	5	1-2
Bold----------	0-60	12-18	1.10-1.30	0.6-2.0	0.20-0.24	7.4-8.4	Low----------	0.43	5-4	4L	.5-2
	7-60	12-18	1.10-1.30	0.6-2.0	0.20-0.24	7.4-8.4	Low----------	0.43			
1013*. Pits											
1027*. Udorthents											
1029*. Pits											
1039*. Urban land											
1055*: Aquolls.											
Histosols.											
1072*. Udorthents											
1815----------	0-18	2-10	1.45-1.55	6.0-20	0.10-0.12	5.6-7.8	Low----------	0.17	5	2	1-2
Zumbro	18-56	2-10	1.45-1.55	6.0-20	0.10-0.12	5.6-7.8	Low----------	0.17			
	56-60	0-10	1.45-1.60	6.0-20	0.05-0.12	6.1-7.8	Low----------	0.17			
1816----------	0-37	18-28	1.25-1.35	0.6-2.0	0.16-0.24	5.6-7.3	Moderate-----	0.32	5	6	5-6
Kennebec Variant	37-60	24-28	1.35-1.40	0.6-2.0	0.16-0.24	5.6-7.3	Moderate-----	0.43			
1821----------	0-12	5-15	1.35-1.50	2.0-6.0	0.12-0.14	5.6-7.3	Low----------	0.17	5	3	1-4
Algansee	12-60	0-18	1.40-1.65	>20	0.05-0.07	5.6-7.8	Low----------	0.17			
1824----------	0-12	22-27	1.00-1.40	0.6-2.0	0.22-0.24	6.6-7.8	Low----------	0.28	5	6	6-15
Quam	12-45	22-35	1.25-1.45	0.2-0.6	0.16-0.22	6.6-7.8	Moderate-----	0.28			
	45-60	20-35	1.40-1.65	0.2-0.6	0.14-0.19	7.4-8.4	Moderate-----	0.37			
1825C----------	0-60	---	0.10-0.25	0.2-6.0	0.35-0.45	5.1-7.8	----------	0.10	5	3	>25
Seelyeville											
1827A, 1827B, 1827C----------	0-36	18-26	1.20-1.50	0.6-2.0	0.20-0.24	5.6-6.5	Low----------	0.32	3	6	2-6
Waukegan	36-40	1-6	1.50-1.70	6.0-20	0.06-0.08	5.6-7.3	Low----------	0.10			
	40	---	---	---	---	---	----------	----			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	G/cm^3	In/hr	In/in	pH					Pct
1848B----------	0-10	1-10	1.55-1.70	6.0-20	0.10-0.12	5.6-6.0	Low----------	0.17	5	2	.5-2
Sparta	10-25	1-5	1.55-1.70	6.0-20	0.06-0.08	5.6-6.0	Low----------	0.17			
	25-42	30-45	1.35-1.55	0.2-2.0	0.14-0.16	5.1-7.8	Moderate-----	0.32			
	42	---	---	---	---	---	----------	----			
1894B----------	0-15	15-27	1.20-1.40	0.6-2.0	0.15-0.22	5.1-6.5	Low----------	0.32	5	5	3-4
Winnebago	15-40	25-35	1.35-1.55	0.6-2.0	0.15-0.19	5.1-6.0	Moderate-----	0.32			
	40-60	15-22	1.40-1.70	0.6-2.0	0.11-0.18	5.6-7.8	Low----------	0.32			
1895B----------	0-13	10-20	1.40-1.55	2.0-6.0	0.13-0.20	5.1-7.8	Low----------	0.20	4	3	2-3
Carmi	13-25	15-22	1.45-1.65	2.0-6.0	0.12-0.19	5.1-6.0	Low----------	0.20			
	25-60	5-15	1.60-1.80	6.0-20	0.02-0.07	5.1-7.8	Low----------	0.15			
1896B*:											
Ostrander-------	0-17	18-27	1.45-1.55	0.6-2.0	0.20-0.24	5.6-7.3	Low----------	0.28	5	6	3-5
	17-53	13-27	1.45-1.65	0.6-2.0	0.17-0.19	5.1-7.3	Low----------	0.28			
	53-60	18-27	1.60-1.80	0.6-2.0	0.17-0.19	6.6-7.8	Low----------	0.37			
Carmi----------	0-13	10-20	1.40-1.55	2.0-6.0	0.13-0.20	5.1-7.8	Low----------	0.20	4	3	2-3
	13-25	15-22	1.45-1.65	2.0-6.0	0.12-0.19	5.1-6.0	Low----------	0.20			
	25-60	5-15	1.60-1.80	6.0-20	0.02-0.07	5.1-7.8	Low----------	0.15			
1898F*:											
Etter----------	0-7	8-15	1.30-1.50	2.0-6.0	0.16-0.18	5.6-7.3	Low----------	0.20	4	3	1-2
	7-21	10-18	1.35-1.55	0.6-2.0	0.17-0.19	5.1-6.5	Low----------	0.20			
	21-60	1-5	1.50-1.70	6.0-20	0.05-0.07	5.1-6.0	Low----------	0.15			
Brodale---------	0-6	5-18	1.15-1.30	0.6-2.0	0.06-0.12	6.6-8.4	Low----------	0.20	2	8	2-5
	6-10	5-18	1.20-1.35	0.6-2.0	0.06-0.12	6.6-8.4	Low----------	0.20			
	10-47	5-18	1.20-1.35	0.6-6.0	0.04-0.09	7.9-8.4	Low----------	0.20			
	47	---	---	---	---	---	----------	----			
1902B----------	0-13	10-20	1.35-1.55	0.6-2.0	0.22-0.24	5.1-7.3	Low----------	0.32	5	5	1-4
Jewett	13-24	18-25	1.55-1.65	0.6-2.0	0.18-0.22	5.1-6.0	Moderate-----	0.32			
	24-33	18-25	1.40-1.70	0.6-2.0	0.12-0.19	5.1-6.0	Moderate-----	0.32			
	33-60	10-20	1.35-1.85	0.6-2.0	0.10-0.12	5.1-6.0	Low----------	0.32			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--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		
		Frequency	Duration	Months	Depth	Kind	Months
					Ft		
2B, 2C---- Ostrander	B	None----	---	---	>6.0	---	---
7A, 7B, 7C, 7D---- Hubbard	A	None----	---	---	>6.0	---	---
8A, 8B---- Sparta	A	None----	---	---	>6.0	---	---
12C---- Emmert	A	None----	---	---	>6.0	---	---
27A, 27B---- Dickinson	B	None----	---	---	>6.0	---	---
39A, 39B, 39B2, 39C, 39C2, 39D---- Wadena	B	None----	---	---	>6.0	---	---
41A, 41B---- Estherville	B	None----	---	---	>6.0	---	---
42C---- Salida	A	None----	---	---	>6.0	---	---
49B---- Antigo	B	None----	---	---	>6.0	---	---
81B, 81C, 81E---- Boone	A	None----	---	---	>6.0	---	---
94C---- Terril	B	None----	---	---	>6.0	---	---
98---- Colo	B/D	Occasional----	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul
100A, 100B, 100C---- Copaston	D	None----	---	---	>6.0	---	---
106B, 106C, 106C2, 106D2---- Lester	B	None----	---	---	>6.0	---	---
109---- Cordova	C/D	None----	---	---	1.0-3.0	Apparent	Nov-May
113---- Webster	B/D	None----	---	---	1.0-2.0	Apparent	Nov-Jul
114---- Glencoe	B/D	Rare----	---	---	+1-1.0	Apparent	Oct-Jun
129---- Cylinder	B	None----	---	---	2.0-4.0	Apparent	Nov-Jul
150B---- Spencer	B	None----	---	---	3.0-6.0	Apparent	Nov-May
151C, 151D---- Burkhardt	B	None----	---	---	>6.0	---	---
155B, 155C, 155E---- Chetek	B	None----	---	---	>6.0	---	---

TABLE 16.--WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table		
		Frequency	Duration	Months	Depth	Kind	Months
					Ft		
173F---------- Frontenac	B	None----------	---	---	>6.0	---	---
176---------- Garwin	B/D	None----------	---	---	1.0-2.0	Apparent	Nov-Jul
177A, 177B, 177C-------- Gotham	A	None----------	---	---	>6.0	---	---
189---------- Auburndale	D	None----------	---	---	+1-1.0	Apparent	Nov-May
203B---------- Joy	B	None----------	---	---	2.0-4.0	Apparent	Apr-Jun
208---------- Kato	B/D	Rare----------	---	---	1.0-2.5	Apparent	Mar-Jun
213B---------- Klinger	B	None----------	---	---	2.0-4.0	Apparent	Nov-Jul
226---------- Lawson	C	Occasional------	Brief---------	Mar-Nov	1.0-3.0	Apparent	Nov-May
239---------- Le Sueur	B	None----------	---	---	2.0-4.0	Perched	Nov-May
250---------- Kennebec	B	Occasional------	Brief---------	Feb-Nov	3.0-5.0	Apparent	Nov-Jul
251D, 251E---------- Marlean	B	None----------	---	---	>6.0	---	---
252---------- Marshan	B/D	None----------	---	---	1.0-2.5	Apparent	Jan-Dec
253---------- Maxcreek	B/D	None----------	---	---	1.0-3.0	Apparent	Apr-Jun
255---------- Mayer	B/D	None----------	---	---	1.0-3.0	Apparent	Oct-Jun
279B, 279C---------- Otterholt	B	None----------	---	---	>6.0	---	---
283A, 283B, 283D-------- Plainfield	A	None----------	---	---	>6.0	---	---
285A, 285B, 285C-------- Port Byron	B	None----------	---	---	>6.0	---	---
299A, 299B, 299C-------- Rockton	B	None----------	---	---	>6.0	---	---
301B---------- Lindstrom	B	None----------	---	---	>6.0	---	---
313---------- Spillville	B	Occasional------	Very brief----	Feb-Nov	3.0-5.0	Apparent	Nov-Jul
317---------- Oshawa	C/D	Frequent--------	Long----------	Apr-Jul	+1-1.0	Apparent	Apr-Jul
318---------- Mayer	B/D	Rare----------	---	---	+1-1.0	Apparent	Jan-Dec
320B, 320C2---------- Tallula	B	None----------	---	---	>6.0	---	---

TABLE 16.--WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table		
		Frequency	Duration	Months	Depth	Kind	Months
					Ft		
342B, 342C, 342E, 342F--Kingsley	B	None	---	---	>6.0	---	---
344--Quam	B/D	None	---	---	+2-1.0	Apparent	Jan-Dec
377B--Merton	B	None	---	---	2.0-5.0	Apparent	Apr-Jun
378--Maxfield	B/D	None	---	---	1.0-2.0	Apparent	Nov-Jul
382B--Blooming	B	None	---	---	>6.0	---	---
408--Faxon	B/D	Frequent	Very brief	Apr-May	0-1.0	Apparent	Nov-May
409B, 409C--Etter	B	None	---	---	>6.0	---	---
411A, 411B, 411C--Waukegan	B	None	---	---	>6.0	---	---
414--Hamel	C	None	---	---	1.0-3.0	Apparent	Nov-Jun
415A, 415B, 415C--Kanaranzi	B	None	---	---	>6.0	---	---
449B--Crystal Lake	B	None	---	---	2.5-6.0	Apparent	Sep-May
454B, 454C, 454E--Mahtomedi	A	None	---	---	>6.0	---	---
463--Minneiska	B	Occasional	Brief	Mar-Jul	3.0-6.0	Apparent	Mar-Jun
465--Kalmarville	B/D	Frequent	Brief	Mar-Jun	0-1.0	Apparent	Mar-Aug
495--Zumbro	A	Rare	---	---	>6.0	---	---
522--Boots	A/D	Frequent	Long	Nov-May	+1-1.0	Apparent	Nov-Aug
539--Palms	A/D	Frequent	Long	Nov-May	+1-1.0	Apparent	Nov-May
540--Seelyeville	A/D	Frequent	Long	Nov-May	+2-2.0	Apparent	Jan-Dec
545--Rondeau	D	Frequent	Long	Nov-May	+1-1.0	Apparent	Jan-Dec
611C, 611D, 611E, 611F--Hawick	A	None	---	---	>6.0	---	---
857A*, 857B*: Urban land.							
Waukegan	B	None	---	---	>6.0	---	---
858C*: Urban land.							

See footnote at end of table.

TABLE 16.--WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table		
		Frequency	Duration	Months	Depth	Kind	Months
					Ft		
858C*:							
Chetek	B	None	---	---	>6.0	---	---
860C*:							
Urban land.							
Lester	B	None	---	---	>6.0	---	---
861C*, 861E*:							
Urban land.							
Kingsley	B	None	---	---	>6.0	---	---
865B*:							
Urban land.							
Hubbard	A	None	---	---	>6.0	---	---
880F*:							
Brodale	C	None	---	---	>6.0	---	---
Rock outcrop.							
888B*, 888C*, 888D*:							
Kingsley	B	None	---	---	>6.0	---	---
Lester	B	None	---	---	>6.0	---	---
889B*, 889C*, 889D*:							
Wadena	B	None	---	---	>6.0	---	---
Hawick	A	None	---	---	>6.0	---	---
895B*, 895C*:							
Kingsley	B	None	---	---	>6.0	---	---
Mahtomedi	A	None	---	---	>6.0	---	---
Spencer	B	None	---	---	2.5-6.0	Apparent	Nov-May
896E*, 896F*:							
Kingsley	B	None	---	---	>6.0	---	---
Mahtomedi	A	None	---	---	>6.0	---	---
963C2*, 963D2*, 963E2*:							
Timula	B	None	---	---	>6.0	---	---
Bold	B	None	---	---	>6.0	---	---
1013*.							
Pits							
1027*.							
Udorthents							
1029*.							
Pits							
1039*.							
Urban land							
1055*:							
Aquolls.							
Histosols.							

See footnote at end of table.

TABLE 16.--WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table		
		Frequency	Duration	Months	Depth	Kind	Months
					Ft		
1072*. Udorthents							
1815---------- Zumbro	A	None----------	---	---	>6.0	---	---
1816---------- Kennebec Variant	B	None----------	---	---	+1-2.0	Perched	Nov-May
1821---------- Algansee	B	Occasional------	Long----------	Nov-May	1.0-2.0	Apparent	Nov-May
1824---------- Quam	B/D	None----------	---	---	+2-1.0	Apparent	Jan-Dec
1825C---------- Seelyeville	D	None----------	---	---	0-2.0	Apparent	Jan-Dec
1827A, 1827B, 1827C----- Waukegan	B	None----------	---	---	>6.0	---	---
1848B---------- Sparta	A	None----------	---	---	>6.0	---	---
1894B---------- Winnebago	B	None----------	---	---	>6.0	---	---
1895B---------- Carmi	B	None----------	---	---	>6.0	---	---
1896B*:							
Ostrander----------	B	None----------	---	---	>6.0	---	---
Carmi----------	B	None----------	---	---	>6.0	---	---
1898F*:							
Etter----------	B	None----------	---	---	>6.0	---	---
Brodale----------	C	None----------	---	---	>6.0	---	---
1902B---------- Jewett	B	None----------	---	---	>6.0	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL FEATURES

[The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Bedrock		Subsidence		Potential frost action	Risk of corrosion	
	Depth	Hardness	Initial	Total		Uncoated steel	Concrete
	In		In	In			
2B, 2C---------- Ostrander	>60	---	---	---	Moderate-------	Moderate-------	Low.
7A, 7B, 7C, 7D---------- Hubbard	>60	---	---	---	Low----------	Low----------	Low.
8A, 8B---------- Sparta	>60	---	---	---	Low----------	Low----------	Moderate.
12C---------- Emmert	>60	---	---	---	Low----------	Low----------	Moderate.
27A, 27B---------- Dickinson	>60	---	---	---	Moderate-------	Low----------	Moderate.
39A, 39B, 39B2, 39C, 39C2, 39D---------- Wadena	>60	---	---	---	Low----------	Low----------	Low.
41A, 41B---------- Estherville	>60	---	---	---	Low----------	Low----------	Low.
42C---------- Salida	>60	---	---	---	Low----------	Low----------	Low.
49B---------- Antigo	>60	---	---	---	High----------	Moderate-------	High.
81B, 81C, 81E---------- Boone	20-40	Soft	---	---	Low----------	Low----------	Moderate.
94C---------- Terril	>60	---	---	---	Moderate-------	Moderate-------	Low.
98---------- Colo	>60	---	---	---	High----------	High----------	Moderate.
100A, 100B, 100C-------- Copaston	12-20	Hard	---	---	Moderate-------	Low----------	Low.
106B, 106C, 106C2, 106D2---------- Lester	>60	---	---	---	Moderate-------	Low----------	Moderate.
109---------- Cordova	>60	---	---	---	High----------	High----------	Low.
113---------- Webster	>60	---	---	---	High----------	High----------	Low.
114---------- Glencoe	>60	---	---	---	High----------	High----------	Low.
129---------- Cylinder	>60	---	---	---	High----------	Moderate-------	Low.
150B---------- Spencer	>60	---	---	---	High----------	Moderate-------	High.
151C, 151D---------- Burkhardt	>60	---	---	---	Low----------	Low----------	High.
155B, 155C, 155E-------- Chetek	>60	---	---	---	Low----------	Low----------	High.

TABLE 17.--SOIL FEATURES--Continued

Soil name and map symbol	Bedrock		Subsidence		Potential frost action	Risk of corrosion	
	Depth	Hardness	Initial	Total		Uncoated steel	Concrete
	In		In	In			
173F---------- Frontenac	>60	---	---	---	Moderate-------	Low----------	Low.
176---------- Garwin	>60	---	---	---	High----------	High----------	Moderate.
177A, 177B, 177C--------- Gotham	>60	---	---	---	Low----------	Low----------	Moderate.
189---------- Auburndale	>60	---	---	---	High----------	High----------	Moderate.
203B---------- Joy	>60	---	---	---	High----------	High----------	Moderate.
208---------- Kato	>60	---	---	---	High----------	High----------	Moderate.
213B---------- Klinger	>60	---	---	---	High----------	High----------	Moderate.
226---------- Lawson	>60	---	---	---	High----------	Moderate-------	Low.
239---------- Le Sueur	>60	---	---	---	High----------	High----------	Low.
250---------- Kennebec	>60	---	---	---	High----------	Moderate-------	Low.
251D, 251E---------- Marlean	>60	---	---	---	Low----------	Low----------	Low.
252---------- Marshan	>60	---	---	---	High----------	High----------	Moderate.
253---------- Maxcreek	>60	---	---	---	High----------	High----------	Low.
255---------- Mayer	>60	---	---	---	High----------	High----------	Low.
279B, 279C---------- Otterholt	>60	---	---	---	High----------	Moderate-------	High.
283A, 283B, 283D-------- Plainfield	>60	---	---	---	Low----------	Low----------	High.
285A, 285B, 285C-------- Port Byron	>60	---	---	---	High----------	Low----------	Moderate.
299A, 299B, 299C-------- Rockton	20-40	Soft	---	---	Moderate-------	Low----------	Low.
301B---------- Lindstrom	>60	---	---	---	High----------	Moderate-------	Moderate.
313---------- Spillville	>60	---	---	---	Moderate-------	High----------	Moderate.
317---------- Oshawa	>60	---	---	---	High----------	High----------	Low.
318---------- Mayer	>60	---	---	---	High----------	High----------	Low.
320B, 320C2---------- Tallula	>60	---	---	---	High----------	Low----------	Low.

TABLE 17.--SOIL FEATURES--Continued

Soil name and map symbol	Bedrock		Subsidence		Potential frost action	Risk of corrosion	
	Depth	Hardness	Initial	Total		Uncoated steel	Concrete
	In		In	In			
342B, 342C, 342E, 342F-- Kingsley	>60	---	---	---	Low	Low	Moderate.
344 Quam	>60	---	---	---	High	High	Low.
377B Merton	>60	---	---	---	High	Low	Moderate.
378 Maxfield	>60	---	---	---	High	High	Moderate.
382B Blooming	>60	---	---	---	Moderate	Moderate	Moderate.
408 Faxon	20-40	Hard	---	---	High	High	Low.
409B, 409C Etter	20-40	---	---	---	Low	Low	High.
411A, 411B, 411C Waukegan	>60	---	---	---	Low	Low	Moderate.
414 Hamel	>60	---	---	---	High	High	Low.
415A, 415B, 415C Kanaranzi	>60	---	---	---	Moderate	Moderate	Low.
449B Crystal Lake	>60	---	---	---	High	Moderate	High.
454B, 454C, 454E Mahtomedi	>60	---	---	---	Low	Low	High.
463 Minneiska	>60	---	---	---	Moderate	Low	Low.
465 Kalmarville	>60	---	---	---	High	Moderate	Low.
495 Zumbro	>60	---	---	---	Low	Low	Low.
522 Boots	>60	---	---	40-55	High	Moderate	Low.
539 Palms	>60	---	2-4	25-32	High	High	Moderate.
540 Seelyeville	>60	---	---	50-55	High	High	Moderate.
545 Rondeau	>60	---	---	35	High	High	Low.
611C, 611D, 611E, 611F-- Hawick	>60	---	---	---	Low	Low	Low.
857A*, 857B*: Urban land.							
Waukegan	>60	---	---	---	Low	Low	Moderate.
858C*: Urban land.							

See footnote at end of table.

TABLE 17.--SOIL FEATURES--Continued

Soil name and map symbol	Bedrock		Subsidence		Potential frost action	Risk of corrosion	
	Depth	Hardness	Initial	Total		Uncoated steel	Concrete
	In		In	In			
858C*:							
Chetek	>60	---	---	---	Low	Low	High.
860C*:							
Urban land.							
Lester	>60	---	---	---	Moderate	Low	Moderate.
861C*, 861E*:							
Urban land.							
Kingsley	>60	---	---	---	Low	Low	Moderate.
865B*:							
Urban land.							
Hubbard	>60	---	---	---	Low	Low	Low.
880F*:							
Brodale	40-80	Hard	---	---	Low	Low	Low.
Rock outcrop.							
888B*, 888C*, 888D*:							
Kingsley	>60	---	---	---	Low	Low	Moderate.
Lester	>60	---	---	---	Moderate	Low	Moderate.
889B*, 889C*, 889D*:							
Wadena	>60	---	---	---	Low	Low	Low.
Hawick	>60	---	---	---	Low	Low	Low.
895B*, 895C*:							
Kingsley	>60	---	---	---	Low	Low	Moderate.
Mahtomedi	>60	---	---	---	Low	Low	High.
Spencer	>60	---	---	---	High	Moderate	High.
896E*, 896F*:							
Kingsley	>60	---	---	---	Low	Low	Moderate.
Mahtomedi	>60	---	---	---	Low	Low	High.
963C2*, 963D2*, 963E2*:							
Timula	>60	---	---	---	High	Low	Low.
Bold	>60	---	---	---	High	Low	Low.
1013*.							
Pits							
1027*.							
Udorthents							
1029*.							
Pits							
1039*.							
Urban land							
1055*:							
Aquolls.							
Histosols.							

See footnote at end of table.

TABLE 17.--SOIL FEATURES--Continued

Soil name and map symbol	Bedrock		Subsidence		Potential frost action	Risk of corrosion	
	Depth	Hardness	Initial	Total		Uncoated steel	Concrete
	In		In	In			
1072*. Udorthents							
1815---------- Zumbro	>60	---	---	---	Low----------	Low----------	Low.
1816---------- Kennebec Variant	>60	---	---	---	High----------	Moderate-------	Low.
1821---------- Algansee	>60	---	---	---	Moderate-------	Low----------	Low.
1824---------- Quam	>60	---	---	---	High----------	High----------	Low.
1825C---------- Seelyeville	>60	---	4-12	50-55	High----------	High----------	Moderate.
1827A, 1827B, 1827C----- Waukegan	30-45	Hard	---	---	Low----------	Low----------	Low.
1848B---------- Sparta	40-60	Hard	---	---	Low----------	Low----------	Low.
1894B---------- Winnebago	>60	---	---	---	Moderate-------	Moderate-------	Moderate.
1895B---------- Carmi	>60	---	---	---	Moderate-------	Low----------	High.
1896B*:							
Ostrander----------	>60	---	---	---	Moderate-------	Moderate-------	Low.
Carmi----------	>60	---	---	---	Moderate-------	Low----------	High.
1898F*:							
Etter----------	20-40	---	---	---	Low----------	Low----------	High.
Brodale----------	40-80	Hard	---	---	Low----------	Low----------	Low.
1902B---------- Jewett	>60	---	---	---	Moderate-------	Moderate-------	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
*Algansee	Mixed, mesic Aquic Udipsamments
*Antigo	Fine-silty over sandy or sandy-skeletal, mixed Typic Glossoboralfs
Aquolls	Mesic Haplaquolls
*Auburndale	Fine-silty, mixed, frigid Typic Glossaqualfs
Blooming	Fine-loamy, mixed, mesic Mollic Hapludalfs
Bold	Coarse-silty, mixed (calcareous), mesic Typic Udorthents
Boone	Mesic, uncoated Typic Quartzipsamments
Boots	Euic, mesic Typic Medihemists
Brodale	Loamy-skeletal, carbonatic, mesic Entic Hapludolls
Burkhardt	Sandy, mixed, mesic Typic Hapludolls
Carmi	Coarse-loamy, mixed, mesic Typic Hapludolls
*Chetek	Coarse-loamy, mixed Eutric Glossoboralfs
Colo	Fine-silty, mixed, mesic Cumulic Haplaquolls
Copaston	Loamy, mixed, mesic Lithic Hapludolls
Cordova	Fine-loamy, mixed, mesic Typic Argiaquolls
*Crystal Lake	Fine-silty, mixed Typic Glossoboralfs
Cylinder	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Aquic Hapludolls
Dickinson	Coarse-loamy, mixed, mesic Typic Hapludolls
Emmert	Sandy-skeletal, mixed, frigid Typic Udorthents
Estherville	Sandy, mixed, mesic Typic Hapludolls
Etter	Coarse-loamy, mixed, mesic Typic Hapludolls
*Faxon	Fine-loamy, mixed, mesic Typic Haplaquolls
Frontenac	Fine-loamy, mixed, mesic Typic Hapludolls
Garwin	Fine-silty, mixed, mesic Typic Haplaquolls
Glencoe	Fine-loamy, mixed, mesic Cumulic Haplaquolls
*Gotham	Sandy, mixed, mesic Psammentic Hapludalfs
Hamel	Fine-loamy, mixed, mesic Typic Argiaquolls
Hawick	Sandy, mixed, mesic Entic Hapludolls
Histosols	Euic Histosols
Hubbard	Sandy, mixed Udorthentic Haploborolls
*Jewett	Fine-loamy, mixed Eutric Glossoboralfs
Joy	Fine-silty, mixed, mesic Aquic Hapludolls
Kalmarville	Coarse-loamy, mixed, nonacid, mesic Mollic Fluvaquents
Kanaranzi	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Kato	Fine-silty over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls
Kennebec	Fine-silty, mixed, mesic Cumulic Hapludolls
Kennebec Variant	Fine-silty, mixed, mesic Cumulic Hapludolls
Kingsley	Coarse-loamy, mixed, mesic Mollic Hapludalfs
*Klinger	Fine-silty, mixed, mesic Aquic Hapludolls
Lawson	Fine-silty, mixed, mesic Cumulic Hapludolls
Le Sueur	Fine-loamy, mixed, mesic Aquic Argiudolls
Lester	Fine-loamy, mixed, mesic Mollic Hapludalfs
Lindstrom	Fine-silty, mixed, mesic Cumulic Hapludolls
Mahtomedi	Mixed, frigid Typic Udipsamments
Marlean	Loamy-skeletal, mixed, mesic Typic Hapludolls
Marshan	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls
Maxcreek	Fine-silty, mixed, mesic Typic Haplaquolls
Maxfield	Fine-silty, mixed, mesic Typic Haplaquolls
Mayer	Fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic Typic Haplaquolls
Merton	Fine-loamy, mixed, mesic Aquic Hapludolls
Minneiska	Coarse-loamy, mixed (calcareous), mesic Mollic Udifluvents
Oshawa	Fine-loamy, mixed (calcareous), mesic Cumulic Haplaquolls
Ostrander	Fine-loamy, mixed, mesic Typic Hapludolls
*Otterholt	Fine-silty, mixed Typic Glossoboralfs
Palms	Loamy, mixed, euic, mesic Terric Medisaprists
Plainfield	Mixed, mesic Typic Udipsamments
Port Byron	Fine-silty, mixed, mesic Typic Hapludolls
*Quam	Fine-silty, mixed, frigid Cumulic Haplaquolls
Rockton	Fine-loamy, mixed, mesic Typic Argiudolls
Rondeau	Marly, euic Limnic Borosaprists
Salida	Sandy-skeletal, mixed, mesic Entic Hapludolls
Seelyeville	Euic Typic Borosaprists
Sparta	Sandy, mixed, mesic Entic Hapludolls
*Spencer	Fine-silty, mixed Typic Glossoboralfs
Spillville	Fine-loamy, mixed, mesic Cumulic Hapludolls
Tallula	Coarse-silty, mixed, mesic Typic Hapludolls
Terril	Fine-loamy, mixed, mesic Cumulic Hapludolls

See footnote at end of table.

TABLE 18.--CLASSIFICATION OF THE SOILS--Continued

Soil name	Family or higher taxonomic class
Timula	Coarse-silty, mixed, mesic Typic Eutrochrepts
Udorthents	Mixed, mesic Udorthents
Wadena	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Waukegan	Fine-silty over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Webster	Fine-loamy, mixed, mesic Typic Haplaquolls
Winnebago	Fine-loamy, mixed, mesic Typic 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.

☆ U.S. GOVERNMENT PRINTING OFFICE : 1983 O - 389-232

Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410, or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.