United States Department of Agriculture

Natural Resources Conservation Service

In cooperation with North Dakota Agricultural Experiment Station; North Dakota Cooperative Extension Service; North Dakota State Soil Conservation Committee; and United States Department of the Interior, Bureau of Indian Affairs

Soil Survey of Rolette County, North Dakota

How To Use This Soil Survey

General Soil Map

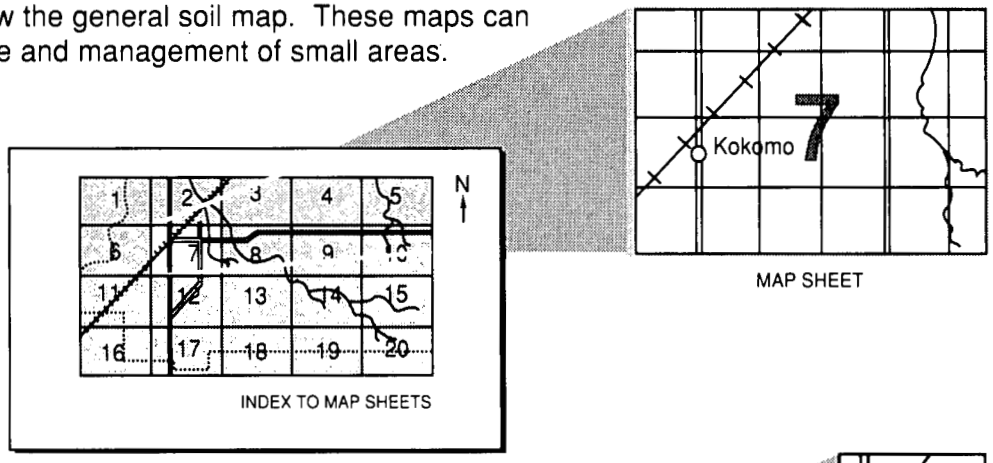
The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

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

Detailed Soil Maps

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

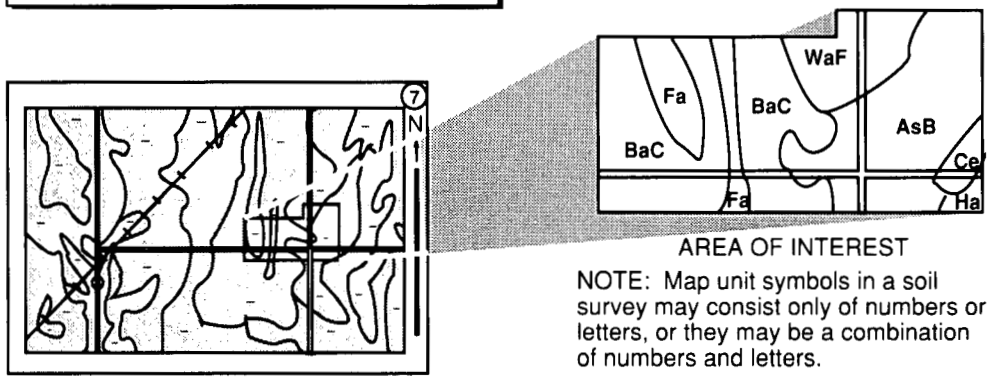
To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



INDEX TO MAP SHEETS

MAP SHEET

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



MAP SHEET

AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

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

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (formerly the Soil Conservation Service) has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1989. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1990. Flights for the photo base were flown in 1984 and 1985. This survey was made cooperatively by the Natural Resources Conservation Service; the North Dakota Agricultural Experiment Station; the North Dakota Cooperative Extension Service; the North Dakota State Soil Conservation Committee; and United States Department of the Interior, Bureau of Indian Affairs. The survey is part of the technical assistance furnished to the Rolette County Soil Conservation District.

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.

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Cover: An area of Maddock, Hecla, and Ulen soils used for cultivated crops. Stripcropping and field windbreaks help to control soil blowing on these soils.

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Foreword

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

This soil survey is designed for many different users. Farmers, 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 ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

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

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

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Soil Survey of Rolette County, North Dakota

By Lynn L. DesLauriers and Ricky E. Lambert, Natural Resources Conservation Service

Fieldwork by Lynn L. DesLauriers, Ricky E. Lambert, Glenn Borchers, and Lance G. Loken, Natural Resources Conservation Service, and Stoneman-Landers, Inc. (Peter Smith), professional soil classifier

Map finishing by the North Dakota State Soil Conservation Committee

United States Department of Agriculture, Natural Resources Conservation Service, in cooperation with
North Dakota Agricultural Experiment Station; North Dakota Cooperative Extension Service; North Dakota State Soil Conservation Committee; and United States Department of the Interior, Bureau of Indian Affairs

ROLETTE COUNTY is in the north-central part of North Dakota (fig. 1). It has a total area of 601,500 acres, of which 585,200 acres is land and 16,300 acres is areas of water more than 40 acres in size. The county is bounded on the north by Canada, on the west by Bottineau County, on the south by Pierce County, and on the east by Towner County. The county seat is Rolla, which is in the northeastern part of the county.

The county is in the Northern Black Glaciated Plains part of the Northern Great Plains Spring Wheat Region *(13)*. The northwestern part of the county is in the Turtle Mountains District, and the rest is in the Drift Plains District of the Central Lowland Province.

A general soil map of Rolette County was published in 1963 and described in a report published in 1968 *(10)*. The county also was included in another general soil map and report published in 1968 *(9)*. The present soil survey updates the earlier surveys. It provides additional information and shows the soils in more detail.

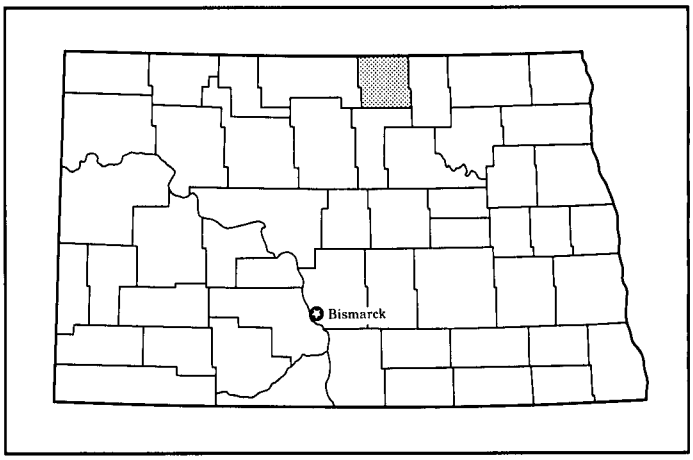

Figure 1.—Location of Rolette County in North Dakota.

General Nature of the County

This section provides general information about Rolette County. It describes the climate; history and development; and physiography, relief, and drainage.

Climate

Rolette County is usually quite warm in summer. It has frequent spells of hot weather and occasional cool days. It is very cold in winter, when arctic air frequently

surges over the survey area. Precipitation falls mainly during the warm period and is normally heaviest in late spring and early summer. Winter snowfall is normally not too heavy, and it is blown into drifts, so that much of the ground is free of snow.

Several times each winter, storms with snow and high winds bring blizzard conditions to the survey area. Hail falls during summer thunderstorms in scattered small areas.

Table 1 gives data on temperature and precipitation for the survey area as recorded at the Belcourt Indian Reservation in the period 1951 to 1986. 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 7 degrees F and the average daily minimum temperature is -4 degrees. The lowest temperature on record, which occurred at the Belcourt Indian Reservation on February 24, 1955, is -45 degrees. In summer, the average temperature is 63 degrees and the average daily maximum temperature is 77 degrees. The highest recorded temperature, which occurred on July 20, 1960, is 100 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 18 inches. Of this, nearly 15 inches, or about 80 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 12 inches. The heaviest 1-day rainfall during the period of record was 4.3 inches at the Belcourt Indian Reservation on July 21, 1965. Thunderstorms occur on about 34 days each year.

The average seasonal snowfall is about 41 inches. The greatest snow depth at any one time during the period of record was 36 inches. On the average, 74 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 55 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the west-northwest. Average windspeed is highest, 12 miles per hour, in spring.

History and Development

The original inhabitants of the area now known as Rolette County were the Chippewa Indians. The Chippewa were Indians of the woods who dwelled mostly in the Turtle Mountains.

The first white men to visit the survey area were fur traders, such as Pierre Verendrye. As early as 1882, a trading post had been established at St. John. At about the same time, a settlement had been started at Dunseith. The communities of Rolla and Rolette were established somewhat later, after the advent of the railroad *(8)*.

Rolette County was established by an act of the Dakota Territorial Legislature in 1873. It was originally called Buffalo County and included parts of what are now Towner and Pierce Counties. In 1883 and again in 1887, the boundaries of the county were changed. The name was changed to Rolette County in honor of "Jolly Joe" Rolette of Pembina.

The county seat was Dunseith when Rolette County was organized. The county seat was later moved to St. John. In 1888, it was moved to Rolla *(8)*.

The population of Rolette County was 2,427 in 1880. By 1940, it reached a peak of 12,583. In 1980, it was 12,177.

Physiography, Relief, and Drainage

The landscape in Rolette County is typical of the undulating to rolling prairies in North Dakota. The county generally is 1,500 to 1,800 feet above sea level. The Turtle Mountains generally rise about 400 to 800 feet above the prairie. A few isolated hills approach an elevation of 2,400 feet *(6)*.

The entire county is covered by remnants of the last glaciation. The county can be divided into five distinct physiographic and geological regions (fig. 2).

The first region is the Turtle Mountains, which make up nearly 30 percent of the county. This region consists of material that was deposited from stagnant ice. The material includes glacial till and outwash in undulating to hilly areas and ice-walled lacustrine deposits in level to strongly sloping areas. The drainage pattern is poorly integrated. Most of the runoff collects in deep depressions, ponds, and lakes. Local relief ranges from less than 1 foot to 10 feet in the areas of ice-walled deposits and from about 20 to 75 feet in the areas of glacial till and outwash.

The eastern third of the county occurs as areas of glacial till deposited on level to undulating ground moraines and on a few hilly end moraines. The drainage pattern generally is poorly integrated. Most of the runoff collects in depressions. A few glacial outwash

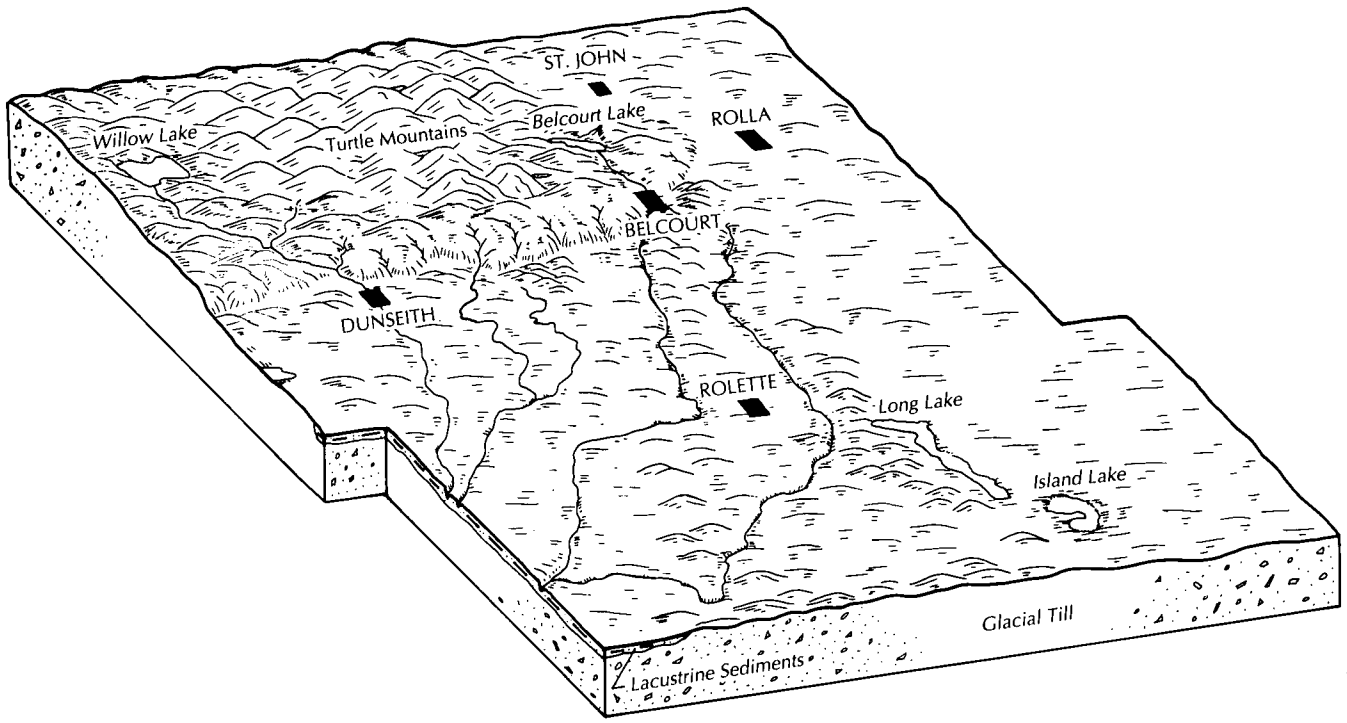

Figure 2.—Physiography, relief, and drainage in Rolette County.

channels transect the region. Local relief ranges from about 5 to 25 feet on the ground moraines and from about 25 to 75 feet on the end moraines.

An extension of glacial Lake Souris covers the area around and to the south of Rolette. It makes up about 7 percent of the county. It consists of eolian material and lacustrine deposits in level to undulating areas. The drainage pattern is poorly integrated. There is very little runoff because of rapid infiltration and permeability in the sandy soils in the area. Local relief ranges from less than 1 foot to about 25 feet.

Level to undulating areas of lacustrine deposits from glacial Lake Souris are in the southwest corner of the county. These areas make up about 5 percent of the county. The drainage pattern is poorly integrated. Most of the runoff collects in depressions. Local relief ranges from less than 1 foot to about 15 feet.

Most areas in the west-central and southwestern parts of the county are covered by a mixture of glacial till, lacustrine material, outwash, and alluvium. The drainage pattern is somewhat integrated. Runoff collects in drainageways and depressions. Local relief ranges from less than 1 foot to about 25 feet.

How This Survey Was Made

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

The soils in the survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a

concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil at a specific location on the landscape.

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

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

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

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

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

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by two or three kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

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

The presence of inclusions in a map unit in no way

diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

Survey Procedures

The general procedures used in making this survey are described in the National Soils Handbook of the Natural Resources Conservation Service and in the "Soil Survey Manual" *(14)*. "The Major Soils of North Dakota" *(9)*, "Soil Taxonomy" *(12)*, and "Land Resource Regions and Major Land Resource Areas of the United States" *(13)* were among the references used. The procedures used in determining the nature and characteristics of the soils are described under the heading "How This Survey Was Made."

Soil scientists traversed the land on foot and by pickup or all-terrain vehicle at an interval close enough for them to locate contrasting soil areas of about 3 to 5 acres. All map units were characterized by transects of representative areas. Generally, one transect was recorded for each 1,000 acres of a given map unit.

Data collected from the transects were used to determine soil names and establish the range of composition of each map unit. The statistical method explained by R.W. Arnold was used *(3)*. This statistical analysis indicates that the map unit composition given in the map unit descriptions is at least 90 percent accurate.

Each soil map unit was documented by at least one pedon description for each soil series identified in its name. Laboratory data were collected in 1988 on nine pedons sampled for engineering properties. The analyses were made by the North Dakota State Highway Department.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils 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 association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

As a result of changes in series concepts, the location of moisture regime areas, differing soil patterns, and differences in the design of the associations, some of the soil boundaries and soil names on the general soil map of this county do not match those on the maps of Bottineau, Towner, and Pierce Counties.

Soil Descriptions

Level to Hilly, Loamy Soils on Till Plains and Moraines

These soils formed in glacial till. They make up about 64 percent of the county. Most areas are used for cultivated crops. Some are used for pasture or hay. The soils are suited to cultivated crops and well suited to hay and pasture. The main concern in managing cultivated areas is controlling water erosion and soil blowing. The main concern in managing areas of hay or pasture is maintaining an adequate cover of the native or introduced forage plants.

1. Kelvin Association

Very deep, medium textured, undulating to hilly, well drained soils in wooded areas

This association is on till plains and moraines. A few scattered deep depressions are throughout most areas. Slopes generally are short and irregular. They range from 3 to 25 percent.

This association makes up about 14 percent of the county. It is about 72 percent Kelvin soils and 28 percent soils of minor extent and water (fig. 3).

Kelvin soils are on summits and side slopes. Typically, the surface layer is dark grayish brown and very dark grayish brown loam about 4 inches thick. It is covered by a 2-inch layer of organic material. The subsoil is about 35 inches thick. It is dark grayish brown. It is clay in the upper part and clay loam in the lower part. The substratum to a depth of about 60 inches is dark brown clay loam.

Eramosh and Rolla are the principal minor soils in this association. Eramosh soils are very poorly drained. They are in deep depressions. Rolla soils are moderately well drained. They are on flats.

Most areas are used for cultivated crops. The steeper areas generally are used for hay or pasture. This association is poorly suited to cultivated crops but is suited to hay and pasture. The minor Eramosh soils are well suited to wetland wildlife habitat. The main concern in managing cultivated areas is controlling water erosion. The main concern in managing areas of hay or pasture is maintaining an adequate cover of the native or introduced forage plants.

2. Bottineau-Buse Association

Very deep, medium textured, undulating to hilly, well drained soils

This association consists of undulating to hilly soils on summits, shoulder slopes, and side slopes on till plains and moraines. Slopes generally are short and irregular. They range from 3 to 25 percent.

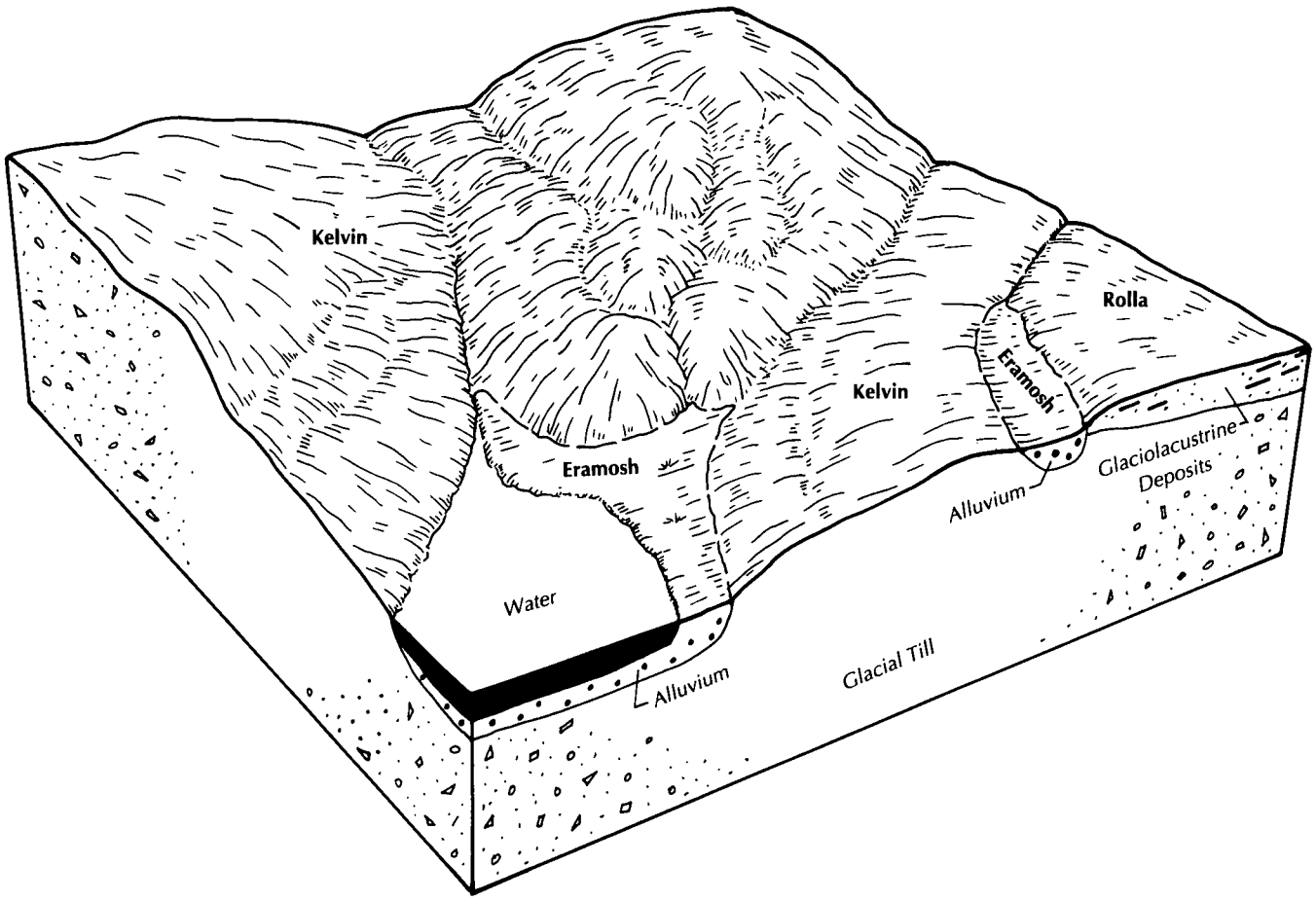

Figure 3.—Typical pattern of soils and parent material in the Kelvin association.

This association makes up about 10 percent of the county. It is about 66 percent Bottineau and similar soils, 15 percent Buse soils, and 19 percent soils of minor extent and water.

The undulating to hilly Bottineau soils are on summits and side slopes. Typically, the surface layer is black loam about 7 inches thick. It is covered with a 2-inch layer of organic material. The subsoil is clay loam about 36 inches thick. It is very dark grayish brown in the upper part, dark grayish brown in the next part, and olive brown in the lower part. The substratum to a depth of about 60 inches is olive brown clay loam.

The undulating to hilly Buse soils are on summits and shoulder slopes. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 30 inches thick. It is pale brown in the upper part and yellowish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown and dark brown loam.

Eramosh soils are the principal minor soils in this association. They are very poorly drained and are in deep depressions.

Most areas are used for cultivated crops. The steeper areas are generally used for hay or pasture. This association is poorly suited to cultivated crops but is suited to hay and pasture. The minor Eramosh soils are well suited to wetland wildlife habitat. The main concern in managing cultivated areas is controlling soil blowing and water erosion. The main concerns in managing areas of hay or pasture are maintaining an adequate cover of the important native or introduced forage plants and controlling soil blowing and water erosion.

3. Barnes-Cresbard-Cavour Association

Very deep, medium textured, level to undulating, well drained and moderately well drained soils

This association consists of level to undulating soils on till plains. The soils are on rises and in swales.

Scattered depressions and flats are throughout most areas. Slopes generally are short and irregular. They range from 0 to 6 percent.

This association makes up about 2 percent of the county. It is about 48 percent Barnes soils, 13 percent Cresbard soils, 10 percent Cavour soils, and 29 percent soils of minor extent.

The level to undulating, well drained Barnes soils are on rises. Typically, the surface layer is black loam about 6 inches thick. The subsoil is loam about 26 inches thick. In sequence downward, it is very dark grayish brown, dark brown, yellowish brown, and light olive brown. The substratum to a depth of about 60 inches is light olive brown loam.

The level to undulating, moderately well drained, sodic Cresbard soils are in swales. Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is very dark grayish brown loam about 2 inches thick. The next layer is very dark grayish brown clay loam about 2 inches thick. The subsoil is about 33 inches thick. It is somewhat dense. It is very dark grayish brown clay loam in the upper part, dark brown clay loam in the next part, and dark grayish brown, mottled loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled loam.

The level to undulating, moderately well drained, sodic Cavour soils are in swales. Typically, the surface layer is black loam about 5 inches thick. The subsurface layer is very dark grayish brown loam about 2 inches thick. The subsoil is about 32 inches thick. It is black clay loam in the upper part; brown, mottled loam in the next part; and dark grayish brown, mottled loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled loam.

Colvin, Divide, Hamerly, and Harriet are the principal minor soils in this association. Colvin and Harriet soils are poorly drained. They are on low flats and in depressions. Divide soils have an accumulation of lime within a depth of 16 inches and have a substratum of gravelly sand and gravelly coarse sand. They are somewhat poorly drained and are on flats and in swales. Hamerly soils have an accumulation of lime within a depth of 16 inches. They are somewhat poorly drained and are on flats.

Most areas are used for cultivated crops. This association is suited to cultivated crops and well suited to hay and pasture. The main concerns in managing cultivated areas are controlling water erosion and reducing moisture stress. The main concern in managing areas of hay or pasture is maintaining an adequate cover of native or introduced forage plants.

4. Barnes-Hamerly-Buse Association

Very deep, medium textured, level to hilly, well drained and somewhat poorly drained soils

This association consists of level to hilly soils on till plains and moraines. The soils are on rises and flats and on the side slopes of knolls and ridges. Scattered depressions are throughout most areas. Slopes generally are short and irregular. They range from 0 to 25 percent.

This association makes up about 34 percent of the county. It is about 44 percent Barnes soils, 17 percent Hamerly soils, 16 percent Buse soils, and 23 percent soils of minor extent (fig. 4).

The level to hilly, well drained Barnes soils are on flats, rises, and side slopes. Typically, the surface layer is black loam about 6 inches thick. The subsoil is loam about 26 inches thick. In sequence downward, it is very dark grayish brown, dark brown, yellowish brown, and light olive brown. The substratum to a depth of about 60 inches is light olive brown loam.

The level and nearly level, somewhat poorly drained Hamerly soils are on flats and around depressions. Typically, the surface layer is black loam about 7 inches thick. The subsoil is mottled loam about 22 inches thick. It is light brownish gray in the upper part and light yellowish brown in the lower part. The next layer is light olive brown, mottled loam about 5 inches thick. The substratum to a depth of about 60 inches is olive brown, mottled loam.

The undulating to hilly, well drained Buse soils are on knolls and ridges. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 30 inches thick. It is pale brown in the upper part and yellowish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown and dark brown loam.

Parnell and Tonka are the principal minor soils in this association. Parnell soils are very poorly drained. They are in deep depressions. Tonka soils are poorly drained. They are in shallow depressions.

Most areas are used for cultivated crops. The steeper areas generally are used for pasture. This association is well suited to cultivated crops, hay, and pasture. The minor Parnell and Tonka soils are well suited to wetland wildlife habitat. The main concern in managing cultivated areas is controlling soil blowing and water erosion. The main concern in managing areas of hay or pasture is maintaining an adequate cover of the important native or introduced forage plants.

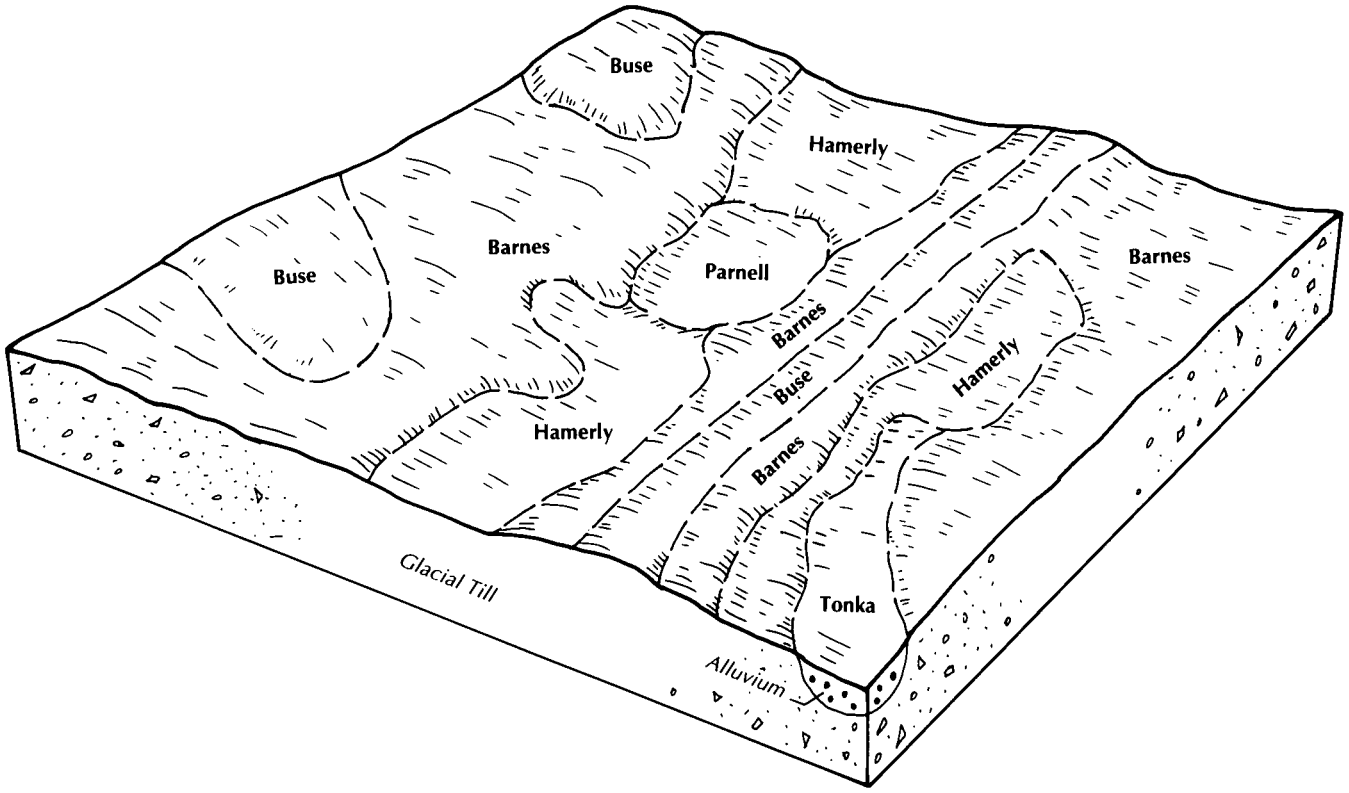

Figure 4.—Typical pattern of soils and parent material in the Barnes-Hamerly-Buse association.

5. Heimdal-Esmond-Emrick Association

Very deep, medium textured, level to hilly, well drained and moderately well drained soils

This association consists of level to hilly soils on till plains and moraines. The soils are on rises, flats, summits, and shoulder slopes and in swales. Slopes generally are short and irregular. They range from 0 to 25 percent.

This association makes up about 4 percent of the county. It is about 30 percent Heimdal soils, 27 percent Esmond soils, 12 percent Emrick soils, and 31 percent soils of minor extent.

The level to hilly, well drained Heimdal soils are on flats, rises, and side slopes. Typically, the surface layer is black loam about 8 inches thick. The subsoil is loam about 24 inches thick. It is dark brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown loam.

The undulating to hilly, well drained Esmond soils are on summits and shoulder slopes. Typically, the surface layer is very dark gray loam about 7 inches thick. The subsoil is loam about 19 inches thick. It is grayish brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is olive brown. It is sandy loam in the upper part and loam in the lower part.

The level to undulating, moderately well drained Emrick soils are in swales. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 39 inches thick. It is very dark grayish brown in the upper part, dark brown in the next part, and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown loam.

Arvilla, Cathay, Harriet, and Maddock are the principal minor soils in this association. Arvilla and Maddock soils are intermingled with areas of the Heimdal soils. Arvilla soils are somewhat excessively drained. They have a surface layer and subsoil of sandy loam and a substratum of gravelly coarse sand. Maddock soils are well drained. They have a surface layer of loamy fine sand and a substratum of fine sand. Cathay soils have a sodic subsoil. They are moderately well drained and are intermingled with areas of the Emrick soils. Harriet soils are poorly drained. They are on low flats.

Most areas are used for cultivated crops. The

steeper areas generally are used for pasture. This association is well suited to cultivated crops, hay, and pasture. The main concern in managing cultivated areas is controlling water erosion and soil blowing. The main concern in managing areas of hay or pasture is maintaining an adequate cover of the important native or introduced forage plants.

Level to Strongly Sloping, Clayey, Silty, and Loamy Soils on Lake Plains

These soils formed in glaciolacustrine deposits. They make up about 9 percent of the county. Most areas are used for cultivated crops. The soils are well suited to cultivated crops, hay, and pasture. The main concerns in managing cultivated areas are controlling soil blowing, improving tilth, and reducing moisture stress.

6. Rolla Association

Very deep, fine textured, level to strongly sloping, moderately well drained soils

This association is on lake plains. Slopes generally are long and smooth. They range from 0 to 15 percent.

This association makes up about 4 percent of the county. It is about 76 percent Rolla soils and 24 percent soils of minor extent and water.

Rolla soils are on flats and side slopes. Typically, the surface layer is dark gray silty clay about 6 inches thick. It is covered by a 2-inch layer of organic material. The subsoil is about 24 inches thick. It is dark grayish brown clay in the upper part, dark grayish brown and dark brown clay in the next part, and dark brown silty clay in the lower part. The substratum to a depth of about 60 inches is dark grayish brown silty clay.

Eramosh, Kelvin, and Metigoshe soils are the principal minor soils in this association. Eramosh soils are very poorly drained. They are in deep depressions. Kelvin and Metigoshe soils are well drained. They are on rises.

Most areas are used for cultivated crops. This association is well suited to cultivated crops, hay, and pasture. The main concerns in managing cultivated areas are controlling soil blowing and water erosion and improving tilth. The main concern in managing areas of hay or pasture is maintaining an adequate cover of the native or introduced forage plants.

7. Gardena-Glyndon-Egeland Association

Very deep, medium textured and moderately coarse textured, level to undulating, well drained to somewhat poorly drained soils

This association consists of level to undulating soils on lake plains. The soils are on rises and flats and in swales. A few scattered depressions are throughout most areas. Slopes generally are long and smooth. They range from 0 to 6 percent.

This association makes up about 2 percent of the county. It is about 35 percent Gardena and similar soils, 20 percent Glyndon and similar soils, 19 percent Egeland soils, and 26 percent soils of minor extent.

The level, moderately well drained Gardena soils are on flats. Typically, the surface soil is black silt loam about 16 inches thick. The subsoil is silt loam about 17 inches thick. It is very dark brown in the upper part, very dark grayish brown in the next part, and light olive brown in the lower part. The substratum to a depth of about 60 inches is olive brown very fine sandy loam. It is mottled between depths of 33 and 51 inches.

The level, somewhat poorly drained Glyndon soils are on flats and in swales. Typically, the surface layer is black silt loam about 7 inches thick. The subsoil is mottled silt loam about 22 inches thick. It is olive gray in the upper part and olive in the lower part. The next layer is olive, mottled silt loam about 15 inches thick. The substratum to a depth of about 60 inches is mottled silt loam. It is olive in the upper part and olive gray and olive brown in the lower part.

The level to undulating, well drained Egeland soils are on rises. Typically, the surface layer is black fine sandy loam about 8 inches thick. The subsoil is fine sandy loam about 25 inches thick. It is dark brown in the upper part and brown in the lower part. The next layer is brown loamy fine sand about 24 inches thick. The substratum to a depth of about 60 inches is brown loamy fine sand.

Aberdeen soils, the saline Bearden soils, and Colvin soils are the principal minor soils in this association. Aberdeen soils have a sodic subsoil. They are moderately well drained and are intermingled with areas of the Gardena soils. The saline Bearden soils are somewhat poorly drained. They are in swales. Colvin soils are poorly drained. They are on flats and in depressions.

Most areas are used for cultivated crops. This association is well suited to cultivated crops, hay, and pasture. The main concern in managing cultivated areas is controlling soil blowing. The main concern in managing areas of hay or pasture is maintaining an adequate cover of the native or introduced forage plants.

8. Aberdeen-Great Bend-Nahon Association

Very deep, medium textured, level and nearly level, moderately well drained and well drained soils

This association consists of level and nearly level soils on lake plains. The soils are on flats and rises and

in swales. Slopes generally are long and smooth. They range from 0 to 3 percent.

This association makes up about 3 percent of the county. It is about 22 percent Aberdeen soils, 21 percent Great Bend and similar soils, 15 percent Nahon soils, and 42 percent soils of minor extent.

The level, moderately well drained, sodic Aberdeen soils are on flats and in swales. Typically, the surface layer is black silt loam about 7 inches thick. The next layer is very dark gray silty clay loam about 3 inches thick. The subsoil is about 15 inches thick. It is black silty clay loam in the upper part and light olive brown silt loam in the lower part. The next layer is olive brown, mottled silt loam about 17 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled silt loam.

The level and nearly level, well drained Great Bend soils are on flats and rises. Typically, the surface layer is black silt loam about 8 inches thick. The subsoil is about 18 inches thick. It is very dark grayish brown silty clay loam in the upper part and yellowish brown silt loam in the lower part. The upper part of the substratum is light olive brown silt loam. The lower part to a depth of about 60 inches is olive brown silty clay loam.

The level, moderately well drained, sodic Nahon soils are on flats and in swales. Typically, the surface layer is black silt loam about 7 inches thick. The subsurface layer is very dark gray silt loam about 2 inches thick. The subsoil is about 37 inches thick. In sequence downward, it is black silty clay loam; yellowish brown silt loam; dark yellowish brown, mottled silt loam; and dark grayish brown, mottled silty clay. The substratum to a depth of about 60 inches is light olive brown, mottled silt loam.

Bearden, Egeland, Harriet, and Maddock are the principal minor soils in this association. Bearden soils have an accumulation of lime within a depth of 16 inches. They are somewhat poorly drained and are on flats. Egeland soils have a surface layer of fine sandy loam and a substratum of loamy fine sand. They are well drained and are on rises. Harriet soils are poorly drained. They are on flats. Maddock soils have a surface layer of loamy fine sand and a substratum of fine sand. They are well drained and are on rises.

Most areas are used for cultivated crops. This association is suited to cultivated crops and well suited to hay and pasture. The main concern in managing cultivated areas is reducing moisture stress. The main concern in managing areas of hay or pasture is maintaining an adequate cover of the native or introduced forage plants.

Level to Undulating, Sandy, Silty, and Loamy Soils on Wind-Sculptured Lake Plains and Flood Plains

These soils formed in eolian soil material and glaciolacustrine deposits. They make up about 20 percent of the county. Most areas are used for cultivated crops, hay, or pasture. The soils are poorly suited to cultivated crops but are suited to hay and pasture. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. The main concerns in managing areas of hay or pasture are maintaining an adequate cover of the suitable native or introduced forage plants and controlling soil blowing.

9. Maddock-Aberdeen-Harriet Association

Very deep, coarse textured and medium textured, level to undulating, well drained, moderately well drained, and poorly drained soils

This association consists of level to undulating soils on wind-sculptured lake plains and flood plains. The soils are on flats and rises and in swales. Slopes generally are short and irregular. They range from 0 to 6 percent.

This association makes up about 13 percent of the county. It is about 26 percent Maddock and similar soils, 25 percent Aberdeen and similar soils, 13 percent Harriet soils, and 36 percent soils of minor extent.

The nearly level to undulating, well drained Maddock soils are on rises. Typically, the surface layer is very dark gray loamy fine sand about 6 inches thick. The subsoil is very dark grayish brown loamy fine sand about 7 inches thick. The next layer is brown fine sand about 20 inches thick. The substratum to a depth of about 60 inches is brown fine sand.

The level, moderately well drained, sodic Aberdeen soils are on flats and in swales. Typically, the surface layer is black silt loam about 7 inches thick. The next layer is very dark gray silty clay loam about 3 inches thick. The subsoil is about 15 inches thick. It is black silty clay loam in the upper part and light olive brown silt loam in the lower part. The next layer is olive brown, mottled silt loam about 17 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled silt loam.

The level, poorly drained Harriet soils are on flats. Typically, the surface layer is very dark gray silt loam about 2 inches thick. The subsoil is silty clay loam about 47 inches thick. It is very dark gray in the upper part, black in the next part, and olive gray and mottled in the lower part. The substratum to a depth of about 60 inches is olive gray silty clay loam.

Arvilla, Letcher, Miranda, and Stirum are the principal minor soils in this association. Arvilla soils are

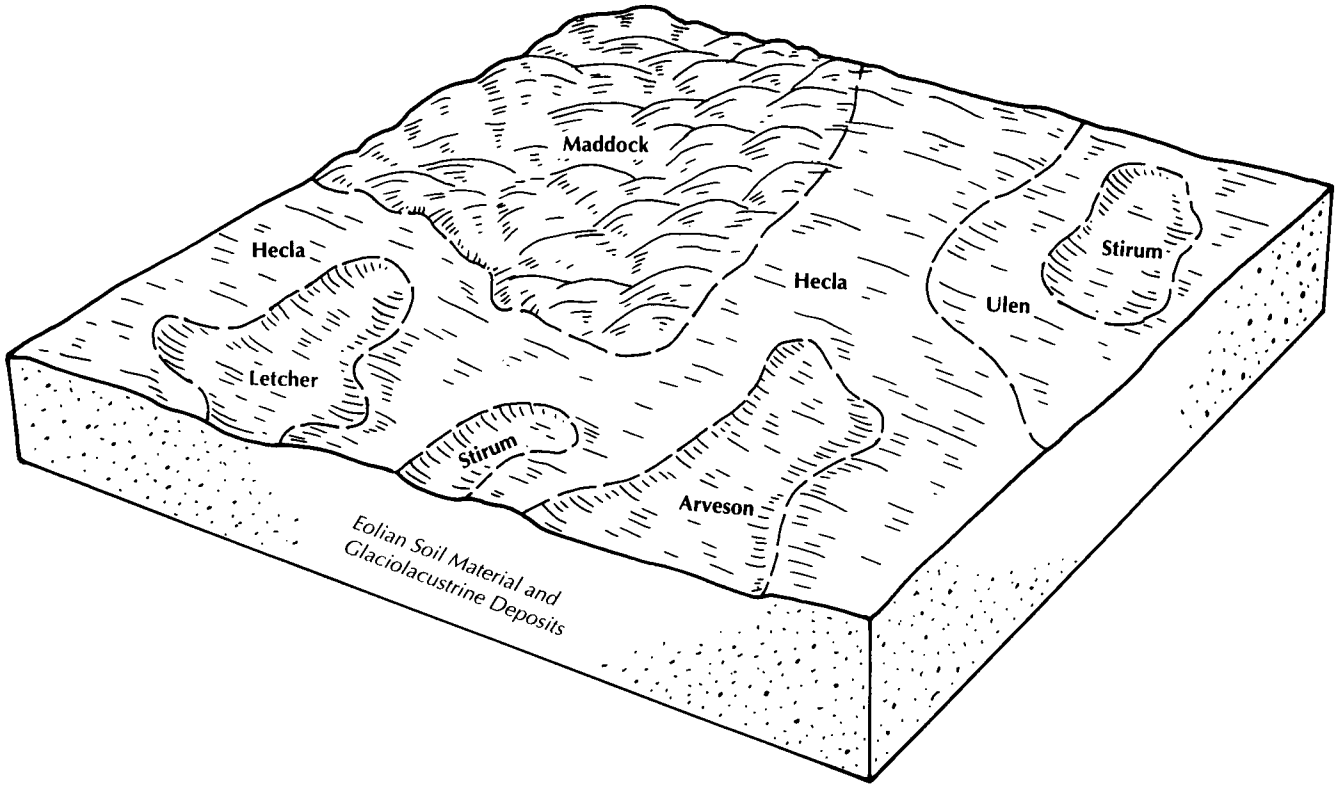

Figure 5.—Typical pattern of soils and parent material in the Hecla-Maddock-Ulen association.

somewhat excessively drained and are intermingled with areas of the Maddock soils. Letcher soils have a surface layer of fine sandy loam and a subsoil of sandy loam and loam. They are moderately well drained and are intermingled with areas of the Aberdeen soils. Miranda soils are somewhat poorly drained and are on flats. Stirum soils are poorly drained and are in swales.

Most areas are used for cultivated crops. Some are used for hay or pasture. This association is poorly suited to cultivated crops but is suited to hay and pasture. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. The main concerns in managing areas of hay or pasture are maintaining an adequate cover of the important native or introduced forage plants, preventing denuding, and controlling soil blowing.

10. Hecla-Maddock-Ulen Association

Very deep, coarse textured and moderately coarse textured, level to undulating, well drained to somewhat poorly drained soils

This association consists of level to undulating soils on wind-sculptured lake plains. The soils are on rises and flats and in swales. A few scattered depressions are throughout most areas. Slopes range from 0 to 6 percent.

This association makes up about 7 percent of the county. It is about 37 percent Hecla soils, 21 percent Maddock soils, 9 percent Ulen and similar soils, and 33 percent soils of minor extent and water (fig. 5).

The level and nearly level, moderately well drained Hecla soils are on flats. Typically, the surface soil is black loamy fine sand about 20 inches thick. The next layer is very dark grayish brown loamy fine sand about 6 inches thick. The substratum to a depth of about 60 inches is mottled. It is brown fine sand in the upper part and grayish brown loamy fine sand in the lower part.

The nearly level and undulating, well drained Maddock soils are on rises. Typically, the surface layer is very dark gray loamy fine sand about 6 inches thick. The subsoil is very dark grayish brown loamy fine sand about 7 inches thick. The next layer is brown fine sand about 20 inches thick. The substratum to a depth of about 60 inches is brown fine sand.

The level, somewhat poorly drained Ulen soils are on flats and in swales. The surface layer is black fine sandy loam about 8 inches thick. The subsoil is dark

gray loamy fine sand about 6 inches thick. The next layer is grayish brown, mottled fine sand about 6 inches thick. The substratum to a depth of about 60 inches is olive, mottled sand.

Arveson, Letcher, and Stirum are the principal minor soils in this association. Arveson and Stirum soils are poorly drained. Arveson soils are in depressions, and Stirum soils are in swales. Letcher soils have a sodic subsoil. They are moderately well drained and are intermingled with areas of the Hecla soils.

Most areas are used for hay and pasture. Some are used for cultivated crops. This association is poorly suited to cultivated crops but is well suited to hay and pasture. The main concerns in managing areas of hay or pasture are maintaining an adequate cover of the important native and introduced forage plants, preventing denuding, and controlling soil blowing. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness.

Level to Hilly, Loamy Soils on Outwash Plains

These soils formed in glaciofluvial deposits. They make up about 7 percent of the county. Most areas are used for cultivated crops. Some are used for hay and pasture. The soils are poorly suited to cultivated crops but are suited to hay and pasture. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. The main concerns in managing areas of hay or pasture are maintaining an adequate cover of the important forage plants, preventing denuding, and controlling soil blowing.

11. Arvilla-Sioux-Divide Association

Very deep, moderately coarse textured and medium textured, level to hilly, somewhat excessively drained, excessively drained, and somewhat poorly drained soils

This association consists of level to hilly soils on outwash plains. The soils are on rises, ridges, and flats and in swales. A few scattered depressions are throughout most areas. Slopes generally are short and irregular. They range from 0 to 25 percent.

This association makes up about 7 percent of the county. It is about 27 percent Arvilla soils, 22 percent Sioux and similar soils, 20 percent Divide soils, and 31 percent soils of minor extent.

The level to undulating, somewhat excessively drained Arvilla soils are on flats and rises. Typically, the surface soil is black sandy loam about 10 inches thick. The subsoil is about 21 inches thick. It is dark brown sandy loam in the upper part and brown gravelly coarse sand in the lower part. The substratum to a depth of about 60 inches is brown gravelly coarse sand.

The level to hilly, excessively drained Sioux soils are on flats, rises, and ridges. Typically, the surface layer is black loam about 5 inches thick. The next layer is very dark grayish brown gravelly sandy loam about 4 inches thick. The substratum to a depth of about 60 inches is brown. It is very gravelly coarse sand in the upper part and gravelly coarse sand in the lower part.

The level, somewhat poorly drained Divide soils are on flats and in swales. Typically, the surface layer is black loam about 8 inches thick. The subsoil is about 17 inches thick. It is gray and very dark gray loam in the upper part and olive gray, mottled gravelly loam in the lower part. The substratum to a depth of about 60 inches is olive. It is gravelly sand in the upper part and mottled gravelly coarse sand in the lower part.

Colvin, Lohnes, and Marysland are the principal minor soils in this association. Colvin and Marysland soils are poorly drained. Colvin soils are on flats and in depressions, and Marysland soils are in swales. Lohnes soils have a surface layer of loamy sand and a subsoil of sand. They are well drained and are intermingled with areas of the Arvilla soils.

Most areas are used for cultivated crops. Some are used for hay and pasture. This association is poorly suited to cultivated crops but is suited to hay and pasture. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. The main concern in managing areas of hay or pasture are controlling soil blowing, maintaining an adequate cover of the important native and introduced forage plants, preventing denuding, and controlling soil blowing.

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 the heading "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 substratum, 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 substratum. 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, Colvin silt loam is a phase of the Colvin series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, 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. Dickey-Esmond-Maddock complex, 9 to 25 percent slopes, is an example.

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

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, sand and 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.

As a result of changes in series concepts, differing soil patterns, and differences in the design of the map units, some of the soil names on the detailed soil maps of this county do not match those on the maps of Bottineau, Pierce, and Towner Counties.

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

17—Aberdeen-Nahon silt loams. These very deep, level, moderately well drained, sodic soils are on lake plains. The Aberdeen soil is on flats and rises. The Nahon soil is on flats. Individual areas range from about 7 to more than 100 acres in size. They are about 45 to 70 percent Aberdeen soil and 15 to 35 percent Nahon soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Aberdeen soil has a surface layer of black silt loam about 7 inches thick. The next layer is very dark gray silty clay loam about 3 inches thick. The subsoil is about 15 inches thick. It is black silty clay loam in the upper part and light olive brown, calcareous silt loam in the lower part. The next layer is olive brown, mottled, calcareous silt loam about 17 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous silt loam.

Typically, the Nahon soil has a surface layer of black silt loam about 7 inches thick. The subsurface layer is very dark gray silt loam about 2 inches thick. The subsoil is about 37 inches thick. In sequence downward, it is black silty clay loam; yellowish brown, calcareous silt loam; dark yellowish brown, mottled, calcareous silt loam; and dark grayish brown, mottled, calcareous silty clay. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous silt loam.

Included with these soils in mapping are small areas of the saline Bearden soils, small areas of Great Bend soils, and some areas of soils that have a saline, sodic subsoil. These included soils make up about 20 percent of the unit. The saline Bearden soils and the soils that have a saline, sodic subsoil are somewhat poorly drained. They are on flats. Great Bend soils do not have a sodic subsoil. They are on rises.

Permeability is slow in the Aberdeen soil and very slow in the Nahon soil. Runoff is slow on both soils. Available water capacity is moderate. Organic matter content is high. A seasonal high water table is at a depth of 4 to 6 feet. The root zone is shallow because of the dense, sodic subsoil. Tilth is fair in the Aberdeen soil and poor in the Nahon soil.

Most areas are used for cultivated crops. Because of the dense, sodic subsoil, these soils are poorly suited to small grain, flax, and sunflowers. The hazards of soil blowing and water erosion are slight. The main concern in managing cultivated areas is improving tilth and root penetration. Crops growing on these soils are characteristically stunted because of moisture stress. Local erosion can be easily controlled by a system of conservation tillage that leaves crop residue on the surface. Growing deep-rooted crops, such as alfalfa, and managing crop residue increase the rate of water infiltration, improve tilth, and improve the penetration of roots in the dense, sodic subsoil.

Intermediate wheatgrass, western wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. The dense, sodic subsoil, which restricts the penetration of roots, and the salts, which reduce the amount of water available to plants, are problems, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the suitable plants helps to control erosion and prevent denuding.

The Aberdeen soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Nahon soil is suited to only a few of the drought- and salt-tolerant species. Supplemental watering helps to ensure the survival of seedlings. Individual trees and shrubs growing on the Nahon soil vary in height, density, and vigor, which are affected by the restricted root development in the dense, sodic subsoil and the reduced available water capacity caused by the salts in the soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification of the Aberdeen soil is IIIs, and that of the Nahon soil is IVs. The productivity index of the unit for spring wheat is 60. The range site of the Aberdeen soil is Clayey, and that of the Nahon soil is Claypan. The pasture group of the Aberdeen soil is Clayey Subsoil, and that of the Nahon soil is Claypan.

64—Arveson loam. This very deep, level, poorly drained, highly calcareous soil is in shallow depressions on outwash plains and lake plains. Individual areas range from about 4 to more than 100 acres in size.

Typically, the surface layer is black, calcareous loam about 8 inches thick. The next layer is very dark gray, calcareous loam about 8 inches thick. The subsoil is very dark gray, calcareous fine sandy loam about 10 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled, and calcareous. It is loamy fine sand in the upper part and fine sand in the lower part.

Included with this soil in mapping are some small areas of soils that have a subsoil of loamy fine sand. These soils make up about 10 percent of the unit. They are intermingled with areas of the Arveson soil.

Permeability is moderate in the Arveson soil. Runoff is very slow. Available water capacity is moderate. Organic matter content is high. A seasonal high water table is within a depth of 2 feet. Tilth is good.

Most areas are used for range, hay, or pasture. If drained, this soil is suited to small grain, flax, and sunflowers. Suitable drainage outlets are not readily available. As a result, few areas are drained. In undrained areas tillage, seeding, and harvesting are frequently delayed or prevented by wetness. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used for range, the important forage plants are big bluestem, switchgrass, and prairie cordgrass. Creeping foxtail, big bluestem, and alsike clover are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover

of the important or suitable plants helps to control soil blowing.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. In undrained areas, however, it is generally unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIw. The productivity index for spring wheat ranges from 30 to 60, depending on the degree of drainage. The range site is Subirrigated. The pasture group is Wet.

66—Arveson loam, wet. This very deep, level, very poorly drained, highly calcareous soil is in deep depressions on outwash plains and lake plains. It is subject to ponding. Individual areas range from about 4 to more than 30 acres in size.

Typically, the surface layer is black, calcareous loam about 8 inches thick. The next layer is very dark gray, calcareous loam about 8 inches thick. The subsoil is very dark gray, calcareous fine sandy loam about 10 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled, and calcareous. It is loamy fine sand in the upper part and fine sand in the lower part.

Included with this soil in mapping are some small areas of soils that have a subsoil of loamy fine sand. These soils make up about 10 percent of the unit. They are intermingled with areas of the Arveson soil.

Permeability is moderate in the Arveson soil. Runoff is ponded. Available water capacity is moderate. Organic matter content is high. A seasonal high water table is 1 foot above to 1 foot below the surface. Tilth is good.

Most areas are used for wetland wildlife habitat. If drained, this soil is poorly suited to small grain, flax, and sunflowers but is suited to range, hay, and pasture. Suitable drainage outlets are not readily available. As a result, few areas are drained. In undrained areas tillage, seeding, and harvesting are frequently delayed or prevented by wetness. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. The soil is occasionally dry enough for hay to be harvested.

The soil and the ponded water provide feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

In areas where this soil is used for range, the important forage plants are rivergrass, northern reedgrass, and slough sedge. In drained areas reed canarygrass and creeping foxtail are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Compaction, trampling, and root shearing are problems, especially if the pasture is grazed during wet periods. Grazing should be deferred when the soil is wet. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. In undrained areas, however, it is generally unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIw. The productivity index for spring wheat ranges from 11 to 47, depending on the degree of drainage. The range site is Wetland. In drained areas the pasture group is Wet.

76—Arvilla sandy loam, 0 to 6 percent slopes. This very deep, level to undulating, somewhat excessively drained soil is on flats and rises on outwash plains. Individual areas range from about 4 to more than 100 acres in size.

Typically, the surface soil is black sandy loam about 10 inches thick. The subsoil is about 21 inches thick. It is dark brown sandy loam in the upper part and brown, calcareous gravelly coarse sand in the lower part. The substratum to a depth of about 60 inches is brown, calcareous gravelly coarse sand. In some areas the surface layer and subsoil are coarse sand or loam.

Included with this soil in mapping are small areas of Sioux and Wyrene soils. These soils make up about 15 percent of the unit. Sioux soils have sand and gravel within a depth of 14 inches. They are intermingled with areas of the Arvilla soil. Wyrene soils are somewhat poorly drained. They are on flats and in swales.

Permeability is moderately rapid in the upper part of

the Arvilla soil and very rapid in the lower part. Runoff is slow. Available water capacity is low. Organic matter content is moderate. The root zone is shallow because of the substratum of gravelly coarse sand. Tilth is good.

Most areas are used for cultivated crops. Because of droughtiness, this soil is very poorly suited to small grain, flax, and sunflowers. Rye or winter wheat makes the best use of the early season moisture supply and helps to control soil blowing in fall, winter, and spring. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main concerns in managing cultivated areas are overcoming droughtiness and controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow and thus increasing the moisture supply. Because of the low available water capacity, little benefit is derived from fallowing. Also, fallowing increases the susceptibility to soil blowing.

Intermediate wheatgrass, pubescent wheatgrass, green needlegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and droughtiness are problems, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants at a height that traps snow increases the moisture supply and helps to control soil blowing. Denuding can occur along cattle trails. It can be prevented by a planned grazing system that controls the pattern of livestock traffic.

This soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It is droughty, and the trees and shrubs commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Because of the low available water capacity, little benefit is derived from fallowing the season prior to planting. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index for spring wheat is 38. The range site and pasture group are Shallow to Gravel.

118—Barnes-Buse loams, 3 to 6 percent slopes. These very deep, undulating, well drained soils are on till plains. The Barnes soil is on side slopes and summits. The Buse soil is on knolls and shoulder slopes (fig. 6). Individual areas range from about 6 to more than 500 acres in size. They are about 40 to 65 percent Barnes soil and 25 to 45 percent Buse soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a surface layer of black loam about 6 inches thick. The subsoil is loam about 26 inches thick. In sequence downward, it is very dark grayish brown, dark brown, yellowish brown and calcareous, and light olive brown and calcareous. The substratum to a depth of about 60 inches is light olive brown loam. In some areas the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Buse soil has a surface layer of black, calcareous loam about 7 inches thick. The subsoil is calcareous loam about 30 inches thick. It is pale brown in the upper part and yellowish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown and dark brown, calcareous loam.

Included with these soils in mapping are small areas of Hamerly and Tonka soils. These included soils make up about 10 percent of the unit. Hamerly soils are somewhat poorly drained. They are on flats. Tonka soils are poorly drained. They are in depressions.

Permeability is moderately slow in the Barnes and Buse soils. Runoff is medium. Available water capacity is high. Organic matter content is high in the Barnes soil and moderate in the Buse soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to small grain, flax, and sunflowers. The hazard of soil blowing is slight on the Barnes soil and moderate on the Buse soil. The hazard of water erosion is moderate on both soils. The main concern in managing cultivated areas is controlling water erosion and soil blowing. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, grassed waterways in areas where runoff concentrates, and field windbreaks help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Water erosion and soil blowing are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control erosion.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Buse soil is suited to only the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on the

Figure 6.—An area of Barnes-Buse loams, 3 to 6 percent slopes. The Buse soil is in the light colored areas on knolls, and the Barnes soil is in the dark areas on side slopes.

Buse soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Barnes soil is IIe, and that of the Buse soil is IIIe. The productivity index of the unit for spring wheat is 65. The range site of the Barnes soil is Silty, and that of the Buse soil is Thin Upland. The pasture group of the Barnes soil is Loamy and Silty, and that of the Buse soil is Thin Upland.

120—Barnes-Buse loams, 6 to 9 percent slopes. These very deep, gently rolling, well drained soils are on till plains. The Barnes soil is on summits and side slopes. The Buse soil is on knolls, ridges, and shoulder slopes. Individual areas range from about 5 to more than 100 acres in size. They are about 50 to 75 percent Barnes soil and 25 to 45 percent Buse soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a surface layer of black loam about 6 inches thick. The subsoil is loam about 26 inches thick. In sequence downward, it is very dark grayish brown, dark brown, yellowish brown and calcareous, and light olive brown and calcareous. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In some areas the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Buse soil has a surface layer of black, calcareous loam about 7 inches thick. The subsoil is calcareous loam about 30 inches thick. It is pale brown

in the upper part and yellowish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown and dark brown, calcareous loam.

Included with these soils in mapping are small areas of Hamerly and Lanona soils. These included soils make up about 5 percent of the unit. Hamerly soils are somewhat poorly drained. They are on flats. Lanona soils have a surface layer and subsoil of fine sandy loam. They are intermingled with areas of the Barnes soil.

Permeability is moderately slow in the Barnes and Buse soils. Runoff is medium. Available water capacity is high. Organic matter content is high in the Barnes soil and moderate in the Buse soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are poorly suited to small grain, flax, and sunflowers. The hazard of soil blowing is moderate on the Buse soil and slight on the Barnes soil. The hazard of water erosion is moderate on both soils. The main concern in managing cultivated areas is controlling water erosion and soil blowing. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, grassed waterways in areas where runoff concentrates, and field windbreaks help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Water erosion and soil blowing are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Buse soil is suited to only the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on the Buse soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Barnes soil is IIIe, and that of the Buse soil is IVe. The productivity index of the unit for spring wheat is 56. The range site of the Barnes soil is Silty, and that of the Buse soil is Thin Upland. The pasture group of the Barnes soil is Loamy and Silty, and that of the Buse soil is Thin Upland.

135—Barnes-Cresbard loams, 3 to 6 percent slopes. These very deep, undulating soils are on till plains. The well drained Barnes soil is on rises. The moderately well drained, sodic Cresbard soil is in swales. Individual areas range from about 6 to more than 70 acres in size. They are about 35 to 60 percent Barnes soil and 25 to 50 percent Cresbard soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a surface layer of black loam about 6 inches thick. The subsoil is loam about 26 inches thick. In sequence downward, it is very dark grayish brown, dark brown, yellowish brown and calcareous, and light olive brown and calcareous. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places it extends to a depth of only 4 to 6 inches.

Typically, the Cresbard soil has a surface layer of black loam about 7 inches thick. The subsurface layer is very dark grayish brown loam about 2 inches thick. The next layer is very dark grayish brown clay loam about 2 inches thick. The subsoil is about 33 inches thick. It is somewhat dense. It is very dark grayish brown clay loam in the upper part, dark brown clay loam in the next part, and dark grayish brown, mottled, calcareous loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

Included with these soils in mapping are small areas of Cavour and Lanona soils. These included soils make up about 10 percent of the unit. Cavour soils have a sodic subsoil that is more dense than that of the Cresbard soil. They are intermingled with areas of the Cresbard soil. The well drained Lanona soils have a surface layer and subsoil of fine sandy loam. They are intermingled with areas of the Barnes soil.

Permeability is moderately slow in the Barnes soil and slow in the Cresbard soil. Runoff is medium on both soils. Available water capacity is high in the Barnes soil and moderate in the Cresbard soil. Organic matter content is high in both soils. A seasonal high water table is at a depth of 4 to 6 feet in the Cresbard soil. The root zone is shallow in the Cresbard soil because of the dense, sodic subsoil. Tilth is good in the Barnes soil and fair in the Cresbard soil.

Most areas are used for cultivated crops. These soils are suited to small grain, flax, and sunflowers. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. The main concerns in managing

cultivated areas are controlling water erosion and improving the penetration of roots in the dense, sodic subsoil of the Cresbard soil. Crops growing on the Cresbard soil are characteristically stunted because of moisture stress. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and grassed waterways in areas where runoff concentrates help to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Growing deep-rooted crops, such as alfalfa, and managing crop residue increase the rate of water infiltration, improve or maintain tilth, and improve the penetration of roots in the dense, sodic subsoil of the Cresbard soil.

Intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control water erosion.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Cresbard soil is suited to many of the climatically adapted species. Individual trees and shrubs growing on the Cresbard soil vary in height, density, and vigor, which are affected by the restricted root development in the dense, sodic subsoil and the reduced available water capacity caused by the salts in the soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification of the Barnes soil is IIe, and that of the Cresbard soil is IIIe. The productivity index of the unit for spring wheat is 71. The range site of the Barnes soil is Silty, and that of the Cresbard soil is Clayey. The pasture group of the Barnes soil is Loamy and Silty, and that of the Cresbard soil is Clayey Subsoil.

137—Barnes-Hamerly loams, 0 to 3 percent slopes. These very deep, level and nearly level soils are on till plains. The well drained Barnes soil is on rises. The somewhat poorly drained, highly calcareous Hamerly soil is on flats. Individual areas range from about 10 to more than 250 acres in size. They are about 60 to 80 percent Barnes soil and 15 to 35 percent Hamerly soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a surface layer of black loam about 6 inches thick. The subsoil is loam about 26 inches thick. In sequence downward, it is very dark grayish brown, dark brown, yellowish brown and calcareous, and light olive brown and calcareous. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In some places the dark color of the surface layer extends to a depth of only 4 to 6 inches. In other places it extends to a depth of more than 16 inches.

Typically, the Hamerly soil has a surface layer of black, calcareous loam about 7 inches thick. The subsoil is mottled, calcareous loam about 22 inches thick. It is light brownish gray in the upper part and light yellowish brown in the lower part. The next layer is light olive brown, mottled, calcareous loam about 5 inches thick. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In some areas the soil has a layer of lime accumulation below a depth of 16 inches.

Included with these soils in mapping are small areas of Parnell, Tonka, and Vallers soils. These included soils make up about 10 percent of the unit. Parnell soils are very poorly drained, and Tonka and Vallers soils are poorly drained. Parnell and Tonka soils are in depressions, and Vallers soils are on flats.

Permeability is moderately slow in the Barnes and Hamerly soils. Runoff is slow. Available water capacity and organic matter content are high. A seasonal high water table is at a depth of 2 to 4 feet in the Hamerly soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are well suited to small grain, flax, and sunflowers. The hazard of soil blowing is slight on the Barnes soil and moderate on the Hamerly soil. The hazard of water erosion is slight on both soils. The main concern in managing cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

Intermediate wheatgrass, tall wheatgrass, smooth bromegrass, big bluestem, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard on the Hamerly soil, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Hamerly soil is suited to all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing

and protect the seedlings from abrasion.

The land capability classification of the Barnes soil is IIc, and that of the Hamerly soil is IIe. The productivity index of the unit for spring wheat is 82. The range site of the Barnes soil is Silty, and that of the Hamerly soil is Limy Subirrigated. The pasture group of the Barnes soil is Loamy and Silty, and that of the Hamerly soil is Limy Subirrigated.

167—Bearden silt loam. This very deep, level, somewhat poorly drained, highly calcareous soil is on flats on lake plains. Individual areas range from about 10 to more than 100 acres in size.

Typically, the surface soil is black, calcareous silt loam about 11 inches thick. The subsoil is calcareous silt loam about 20 inches thick. It is brown in the upper part and light olive brown in the lower part. The next layer is olive, mottled, calcareous silt loam about 16 inches thick. The substratum to a depth of about 60 inches is olive, mottled, calcareous silt loam. In some places the soil has a layer of lime accumulation below a depth of 16 inches. In other places the soil contains less clay.

Included with this soil in mapping are small areas of the saline Bearden soils and small areas of Colvin and Great Bend soils. These soils make up about 25 percent of the unit. The saline Bearden soils are intermingled with areas of this Bearden soil. Colvin soils are poorly drained. They are in swales and depressions. Great Bend soils are well drained. They are on rises.

Permeability is moderately slow in the Bearden soil. Runoff is slow. Available water capacity and organic matter content are high. A seasonal high water table is at a depth of 2 to 4 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to small grain, flax, and sunflowers. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The main concern in managing cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

Tall wheatgrass, smooth bromegrass, big bluestem, and birdsfoot trefoil are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIe. The productivity index for spring wheat is 87. The range site and pasture group are Limy Subirrigated.

169—Bearden silt loam, saline, 0 to 3 percent slopes. This very deep, level and nearly level, somewhat poorly drained, highly calcareous, moderately saline soil is on flats on lake plains. Individual areas range from about 5 to more than 60 acres in size.

Typically, the surface soil is black, calcareous silt loam about 11 inches thick. It has an accumulation of salts. The subsoil is calcareous silt loam about 20 inches thick. It is brown in the upper part and light olive brown in the lower part. The next layer is olive, mottled, calcareous silt loam about 16 inches thick. The substratum to a depth of about 60 inches also is olive, mottled, calcareous silt loam. In some areas the soil is nonsaline.

Included with this soil in mapping are small areas of Aberdeen, Colvin, and Tonka soils. These soils make up about 15 percent of the unit. Aberdeen soils have a sodic subsoil. They are on rises. Colvin and Tonka soils are poorly drained. They are in depressions.

Permeability is moderately slow in the Bearden soil. Runoff is slow. Available water capacity is moderate. The salts in the soil reduce the amount of water available to plants. Organic matter content is high. A seasonal high water table is at a depth of 2 to 4 feet. Tilth is good.

Most areas are used for cultivated crops. Because of salinity, this soil is poorly suited to small grain, flax, and sunflowers. It is best suited to salt-tolerant crops, hay, and pasture. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The main concerns in managing cultivated areas are controlling soil blowing and overcoming salinity. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. A permanent cover of crops helps to control the accumulation of salts in the surface layer by reducing the evaporation rate at the surface.

Tall wheatgrass, slender wheatgrass, alsike clover, and sweetclover are suitable hay and pasture plants. Soil blowing is a hazard. The high content of salts and the limited available water capacity are problems, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable salt-tolerant plants helps

to control soil blowing. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil is suited to only a few of the most salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the reduced available water capacity caused by the salts in the soil. Reducing the evaporation rate at the surface improves seedling survival. If the surface is bare as the soil becomes dry, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIs. The productivity index for spring wheat is 51. The range site is Saline Lowland. The pasture group is Saline.

268—Bottineau loam, 3 to 9 percent slopes. This very deep, undulating and gently rolling, well drained soil is on side slopes on till plains. Individual areas range from about 10 to more than 700 acres in size.

Typically, the surface layer is black loam about 7 inches thick. It is covered by a 2-inch layer of organic material. The subsoil is clay loam about 36 inches thick. It is very dark grayish brown in the upper part, dark grayish brown in the next part, and olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous clay loam. In some areas the dark color of the surface layer extends to a depth of only 4 to 6 inches.

Included with this soil in mapping are small areas of the very poorly drained Eramosh soils in depressions. These soils make up about 5 percent of the unit.

Permeability is moderately slow in the Bottineau soil. Runoff is medium. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. Some areas of native woodland are used for pasture and wildlife habitat. This soil is suited to small grain and flax. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. The main concern in managing cultivated areas is controlling water erosion. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and grassed waterways in areas where runoff concentrates help to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

Intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control water erosion.

This soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIIe. The productivity index for spring wheat is 67. No range site is assigned. The pasture group is Loamy and Silty.

271—Bottineau loam, 9 to 25 percent slopes. This very deep, rolling and hilly, well drained soil is on side slopes and knolls on till plains and moraines. Individual areas range from about 10 to more than 1,000 acres in size.

Typically, the surface layer is black loam about 7 inches thick. It is covered by a 2-inch layer of organic material. The subsoil is clay loam about 36 inches thick. It is very dark grayish brown in the upper part, dark grayish brown in the next part, and olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous clay loam. In some areas the dark color of the surface layer extends to a depth of only 4 to 6 inches.

Included with this soil in mapping are small areas of the very poorly drained Eramosh soils in depressions. These soils make up about 5 percent of the unit.

Permeability is moderately slow in the Bottineau soil. Runoff is rapid. Available water capacity and organic matter content are high.

Most of the acreage is native woodland used for pasture and wildlife habitat. Some areas are used for cultivated crops or hay. Because of the slope and a severe hazard of water erosion, this soil is generally unsuited to cultivated crops. Converting cultivated areas to pasture helps to control erosion. Intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

This soil is generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special treatment, such as hand or scalp planting, is applied.

The land capability classification is VIe. The

productivity index for spring wheat is 0. No range site is assigned. The pasture group is Loamy and Silty.

314—Buse-Barnes loams, 9 to 15 percent slopes. These very deep, rolling, well drained soils are on till plains and moraines. The Buse soil is on shoulder slopes. The Barnes soil is on side slopes and summits. Individual areas range from about 5 to more than 100 acres in size. They are about 45 to 70 percent Buse soil and 25 to 50 percent Barnes soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Buse soil has a surface layer of black, calcareous loam about 7 inches thick. The subsoil is calcareous loam about 30 inches thick. It is pale brown in the upper part and yellowish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown and dark brown, calcareous loam. In some areas the dark color of the surface layer extends to a depth of only 3 to 5 inches.

Typically, the Barnes soil has a surface layer of black loam about 6 inches thick. The subsoil is loam about 26 inches thick. In sequence downward, it is very dark grayish brown, dark brown, yellowish brown and calcareous, and light olive brown and calcareous. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In some areas the dark color of the surface layer extends to a depth of more than 16 inches.

Included with these soils in mapping are small areas of Dickey and Swenoda soils. These included soils make up about 5 percent of the unit. The well drained Dickey soils are loamy fine sand in the surface layer and in the upper part of the subsoil. They are intermingled with areas of the Barnes soil. The moderately well drained Swenoda soils are on flats and in swales.

Permeability is moderately slow in the Buse and Barnes soils. Runoff is rapid. Available water capacity is high. Organic matter content is moderate in the Buse soil and high in the Barnes soil.

Most areas are used for cultivated crops. Some are used for range, hay, or pasture. Because of the slope and a severe hazard of water erosion, these soils are generally unsuited to small grain and flax. They are best suited to range, hay, and pasture.

In areas where these soils are used for range, the important forage plants are western wheatgrass, needleandthread, green needlegrass, and little bluestem. Intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Buse soil is generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Barnes soil is suited to nearly all of the climatically adapted species. Trees and shrubs can be grown on the Buse soil for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification of the Buse soil is VIe, and that of the Barnes soil is IVe. The productivity index of the unit for spring wheat is 0. The range site of the Buse soil is Thin Upland, and that of the Barnes soil is Silty. The pasture group of the Buse soil is Thin Upland, and that of the Barnes soil is Loamy and Silty.

318—Buse-Barnes loams, 15 to 25 percent slopes. These very deep, hilly, well drained soils are on till plains and moraines. The Buse soil is on shoulder slopes. The Barnes soil is on side slopes and summits. Individual areas range from about 5 to more than 200 acres in size. They are about 45 to 70 percent Buse soil and 25 to 50 percent Barnes soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Buse soil has a surface layer of black, calcareous loam about 7 inches thick. The subsoil is calcareous loam about 30 inches thick. It is pale brown in the upper part and yellowish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown and dark brown, calcareous loam. In some areas the dark color of the surface layer extends to a depth of only 3 to 5 inches.

Typically, the Barnes soil has a surface layer of black loam about 6 inches thick. The subsoil is loam about 26 inches thick. In sequence downward, it is very dark grayish brown, dark brown, yellowish brown and calcareous, and light olive brown and calcareous. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In some areas the dark color of the surface layer extends to a depth of more than 16 inches.

Included with these soils in mapping are small areas of the moderately well drained Swenoda soils on flats and in swales. These included soils make up about 5 percent of the unit.

Permeability is moderately slow in the Buse and Barnes soils. Runoff is very rapid. Available water

capacity is high. Organic matter content is moderate in the Buse soil and high in the Barnes soil.

Most areas are used for range, hay, or pasture. Because of the slope and a severe hazard of water erosion, these soils are generally unsuited to cultivated crops. The important forage plants in areas of range are western wheatgrass, needleandthread, green needlegrass, and little bluestem. Intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

These soils are generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be planted for esthetic purposes or to enhance wildlife habitat if special treatment, such as hand or scalp planting, is applied.

The land capability classification of the Buse soil is VIIe, and that of the Barnes soil is VIe. The productivity index of the unit for spring wheat is 0. The range site of the Buse soil is Thin Upland, and that of the Barnes soil is Silty. The pasture group of the Buse soil is Thin Upland, and that of the Barnes soil is Loamy and Silty.

389—Cathay-Larson loams, 0 to 6 percent slopes. These very deep, level to undulating, moderately well drained, sodic soils are on till plains. The Cathay soil is on flats and rises. The Larson soil is on flats and in swales. Individual areas range from about 4 to more than 100 acres in size. They are about 25 to 50 percent Cathay soil and 25 to 45 percent Larson soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Cathay soil has a surface layer of black loam about 7 inches thick. The subsurface layer is very dark grayish brown loam about 2 inches thick. The next layer is very dark grayish brown clay loam about 3 inches thick. The subsoil is about 19 inches thick. It is very dark grayish brown clay loam in the upper part; dark brown, calcareous clay loam in the next part; and light olive brown, calcareous loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

Typically, the Larson soil has a surface layer of black loam about 9 inches thick. The subsurface layer is dark grayish brown fine sandy loam about 3 inches thick. The subsoil is loam about 18 inches thick. It is very dark grayish brown in the upper part, dark grayish brown and calcareous in the next part, and olive brown, mottled, and calcareous in the lower part. The substratum to a depth of about 60 inches is mottled, calcareous loam. It is light olive brown in the upper part and grayish brown in the lower part.

Included with these soils in mapping are small areas of Heimdal and Swenoda soils and some areas of somewhat poorly drained, saline soils. These included soils make up about 20 percent of the unit. Heimdal and Swenoda soils do not have a sodic subsoil. Heimdal soils are on rises. Swenoda soils are intermingled with areas of the Cathay and Larson soils. The somewhat poorly drained, saline soils are on flats.

Permeability is slow in the Cathay and Larson soils. Runoff also is slow. Available water capacity and organic matter content are moderate. A seasonal high water table is at a depth of 3 to 5 feet in the Cathay soil and 3 to 6 feet in the Larson soil. The root zone is shallow because of the dense, sodic subsoil in both soils. Tilth is fair in the Cathay soil and poor in the Larson soil.

Most areas are used for cultivated crops. Because of the dense, sodic subsoil, these soils are poorly suited to small grain, flax, and sunflowers. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. The main concerns in managing cultivated areas are controlling water erosion and improving root penetration. Crops growing on these soils are characteristically stunted because of moisture stress. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and grassed waterways in areas where runoff concentrates help to control water erosion. Growing deep-rooted crops, such as alfalfa, and managing crop residue increase the rate of water infiltration and improve tilth and the penetration of roots in the dense, sodic subsoil.

Intermediate wheatgrass, western wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. Water erosion is a hazard. The dense, sodic subsoil, which restricts the penetration of roots, and the salts, which reduce the amount of water available to plants, are problems, especially if the pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the suitable plants helps to control water erosion and prevent denuding.

The Cathay soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Larson soil is suited to only a few of the drought- and salt-tolerant species. Supplemental watering helps to ensure the survival of seedlings on the Larson soil. Individual trees and shrubs vary in height, density, and vigor, which are affected by the restricted root development in the

dense, sodic subsoil and the reduced available water capacity caused by the salts in the soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification of the Cathay soil is IIIe, and that of the Larson soil is IVs. The productivity index of the unit for spring wheat is 55. The range site of the Cathay soil is Clayey, and that of the Larson soil is Claypan. The pasture group of the Cathay soil is Clayey Subsoil, and that of the Larson soil is Claypan.

392—Cavour-Cresbard loams, 0 to 6 percent slopes. These very deep, level to undulating, moderately well drained, sodic soils are on till plains. The Cavour soil is in swales. The Cresbard soil is on rises. Individual areas range from about 5 to more than 60 acres in size. They are about 35 to 60 percent Cavour soil and 25 to 50 percent Cresbard soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Cavour soil has a surface layer of black loam about 5 inches thick. The subsurface layer is very dark grayish brown loam about 2 inches thick. The subsoil is about 32 inches thick. It is black clay loam in the upper part; brown, mottled, calcareous loam in the next part; and dark grayish brown, mottled, calcareous loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

Typically, the Cresbard soil has a surface layer of black loam about 7 inches thick. The subsurface layer is very dark grayish brown loam about 2 inches thick. The next layer is very dark grayish brown clay loam about 2 inches thick. The subsoil is about 33 inches thick. It is very dark grayish brown clay loam in the upper part, dark brown clay loam in the next part, and dark grayish brown, mottled, calcareous loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

Included with these soils in mapping are small areas of Barnes soils, the saline Hamerly soils, and Miranda soils. These included soils make up about 15 percent of the unit. Barnes soils are well drained. They are on rises. The saline Hamerly soils and the Miranda soils are somewhat poorly drained. They are on flats.

Permeability is very slow in the Cavour soil and slow in the Cresbard soil. Runoff is slow on the Cavour soil and medium on the Cresbard soil. Available water capacity is moderately low in the Cavour soil and moderate in the Cresbard soil. Organic matter content is moderate in the Cavour soil and high in the Cresbard soil. A seasonal high water table is at a depth of 4 to 6 feet in both soils. The root zone is shallow in both soils because of the dense, sodic subsoil. Tilth is poor in the Cavour soil and fair in the Cresbard soil.

Most areas are used for cultivated crops. Because of the dense, sodic subsoil, these soils are poorly suited to small grain, flax, and sunflowers. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. The main concerns in managing cultivated areas are controlling water erosion and improving root penetration. Crops growing on these soils are characteristically stunted because of moisture stress. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and grassed waterways in areas where runoff concentrates help to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Growing deep-rooted crops, such as alfalfa, and managing crop residue increase the rate of water infiltration and improve tilth and the penetration of roots in the dense, sodic subsoil.

Intermediate wheatgrass, western wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. Water erosion is a hazard, especially if the pasture is overgrazed. The dense, sodic subsoil, which restricts the penetration of roots, and the salts, which reduce the amount of water available to plants, are problems. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the suitable plants helps to control erosion and prevent denuding.

The Cavour soil is suited to only a few of the drought- and salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Cresbard soil is suited to many of the climatically adapted species. Supplemental watering helps to ensure the survival of seedlings on the Cavour soil. Individual trees and shrubs growing on the Cavour soil vary in height, density, and vigor, which are affected by the restricted root development in the dense, sodic subsoil and the reduced available water capacity caused by the salts in the soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification of the Cavour soil is IVs, and that of the Cresbard soil is IIIe. The productivity index of the unit for spring wheat is 50. The range site of the Cavour soil is Claypan, and that of the Cresbard soil is Clayey. The pasture group of the Cavour soil is Claypan, and that of the Cresbard soil is Clayey Subsoil.

430—Claire-Lohnes complex, 6 to 25 percent slopes. These very deep, gently rolling to hilly soils are on outwash plains. The excessively drained Claire soil is on summits and shoulder slopes. The well drained Lohnes soil is on side slopes and foot slopes. Individual areas range from about 7 to more than 100 acres in size. They are about 30 to 55 percent Claire soil and 30 to 55 percent Lohnes soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Claire soil has a surface layer of very dark grayish brown, calcareous coarse sand about 4 inches thick. The substratum to a depth of about 60 inches is calcareous. It is brown coarse sand in the upper part, dark brown coarse sand in the next part, and dark brown sand in the lower part. In some places the surface layer and substratum are fine sand. In other places, the surface layer is loam and the substratum is gravelly coarse sand.

Typically, the Lohnes soil has a surface soil of loamy sand about 14 inches thick. The surface soil is black in the upper part and very dark grayish brown in the lower part. The subsoil is dark brown loamy sand about 6 inches thick. The substratum to a depth of about 60 inches is dark brown, calcareous coarse sand. In some areas, the surface layer is loamy fine sand and the substratum is fine sand.

Included with these soils in mapping are small areas of Arvilla and Embden soils. These included soils make up about 10 percent of the unit. Arvilla soils are sandy loam in the surface layer and in the upper part of the subsoil. They are intermingled with areas of the Lohnes soil. Embden soils are moderately well drained. They are on flats.

Permeability is rapid in the Claire and Lohnes soils. Runoff is very slow. Available water capacity is very low. Organic matter content is low in the Claire soil and moderately low in the Lohnes soil.

Most areas are used for range, hay, or pasture. Because of droughtiness, the slope, and a severe hazard of soil blowing, these soils are generally unsuited to cultivated crops. The important forage plants in areas of range are prairie sandreed, sand bluestem, and needleandthread. Intermediate wheatgrass, slender wheatgrass, green needlegrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing. Denuding can occur along cattle trails. It can be prevented by a planned grazing system that controls the pattern of livestock traffic.

These soils are generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

The land capability classification of both soils is VIe. The productivity index of the unit for spring wheat is 0. The range site of the Claire soil is Thin Sands, and that of the Lohnes soil is Sands. The pasture group of both soils is Shallow to Gravel.

450—Colvin silt loam. This very deep, level, poorly drained, highly calcareous soil is on flats and in swales on lake plains and in drainageways on till plains. Individual areas range from about 5 to more than 100 acres in size.

Typically, the surface soil is black, calcareous silt loam about 12 inches thick. The subsoil is calcareous silt loam about 21 inches thick. It is gray in the upper part and light olive gray and mottled in the lower part. The substratum to a depth of about 60 inches is pale olive, mottled, calcareous silt loam. In some areas the substratum is gravelly coarse sand.

Included with this soil in mapping are small areas of the saline Colvin soils. These soils make up about 5 percent of the unit. They are intermingled with areas of the Colvin soil.

Permeability is moderately slow in the Colvin soil. Runoff is very slow. Available water capacity and organic matter content are high. A seasonal high water table is within a depth of 1 foot. Tilth is good.

Most areas are used for range, hay, or pasture. If drained, this soil is suited to small grain, flax, and sunflowers. Suitable drainage outlets are not readily available. As a result, few areas are drained. In undrained areas wetness frequently delays or prevents tillage, seeding, and harvesting. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The main concerns in managing cultivated areas are overcoming wetness and controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. A surface drainage system improves the suitability for crops.

In areas where this soil is used for range, the important forage plants are big bluestem, switchgrass, and prairie cordgrass. Creeping foxtail, big bluestem, and alsike clover are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed during wet periods. Grazing should be deferred when the soil is wet. Maintaining an adequate

cover of the important or suitable plants helps to control soil blowing.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. In undrained areas, however, it is generally unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIw. The productivity index for spring wheat ranges from 39 to 68, depending on the degree of drainage. The range site is Subirrigated. The pasture group is Wet.

451—Colvin silt loam, channeled. This very deep, level, poorly drained, highly calcareous soil is on flats on bottom land. It is frequently flooded. The landscape is dissected by drainage channels that generally are too wet or too deep to be crossed by machinery (fig. 7). Individual areas range from about 10 to more than 100 acres in size.

Typically, the surface soil is black, calcareous silt loam about 12 inches thick. The subsoil is calcareous silt loam about 21 inches thick. It is gray in the upper part and light olive gray and mottled in the lower part. The substratum to a depth of about 60 inches is pale olive, mottled, calcareous silt loam. In some places the soil has a layer of lime accumulation below a depth of 16 inches. In other places the soil is saline. In some areas the substratum is gravelly coarse sand.

Included with this soil in mapping are small areas of the very poorly drained Colvin soils in depressions and channels. These soils make up about 5 percent of the unit.

Permeability is moderately slow in the Colvin soil. Runoff is very slow. Available water capacity and organic matter content are high. A seasonal high water table is within a depth of 1 foot.

Most areas are used for range, hay, or pasture. Because of wetness, flooding, and the meandering channels, this soil is generally unsuited to cultivated crops and to trees and shrubs. The important forage plants in areas of range are big bluestem, switchgrass, and prairie cordgrass. Creeping foxtail, big bluestem, and alsike clover are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Compaction, trampling, and root shearing are problems, especially if the pasture is grazed during wet periods. Grazing should be deferred when the soil is wet. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

The land capability classification is VIw. The productivity index for spring wheat is 0. The range site is Subirrigated. The pasture group is Wet.

452—Colvin silt loam, saline. This very deep, level, poorly drained, highly calcareous, moderately saline soil is on flats and in swales on lake plains and in drainageways on till plains. Individual areas range from about 5 to more than 70 acres in size.

Typically, the surface soil is black, calcareous silt loam about 12 inches thick. It has an accumulation of salts. The subsoil is calcareous silt loam about 21 inches thick. It is gray in the upper part and light olive gray and mottled in the lower part. The substratum to a depth of about 60 inches is pale olive, mottled, calcareous silt loam. In some places the substratum is gravelly coarse sand. In other places the soil has a layer of lime accumulation below a depth of 16 inches.

Included with this soil in mapping are small areas of the nonsaline Colvin soils. These soils make up about 5 percent of the unit. They are intermingled with areas of the saline Colvin soil.

Permeability is moderately slow in the Colvin soil. Runoff is very slow. Available water capacity is moderate. The salts in the soil reduce the amount of water available to plants. Organic matter content is high. A seasonal high water table is within a depth of 2 feet. Tilth is good.

Most areas are used for range, hay, or pasture. If drained, this soil is poorly suited to small grain, flax, and sunflowers because of salinity. Suitable drainage outlets are not readily available. As a result, few areas are drained. In undrained areas wetness frequently delays or prevents tillage, seeding, and harvesting. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The main concerns in managing cultivated areas are controlling soil blowing and overcoming salinity. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. A permanent cover of crops helps to control the accumulation of salts in the surface layer by reducing the evaporation rate at the surface.

In areas where this soil is used for range, the important forage plants are inland saltgrass, alkali cordgrass, and Nuttall alkaligrass. Tall wheatgrass, beardless wildrye, alsike clover, and sweetclover are suitable hay or pasture plants. Soil blowing is a hazard. The high content of salts and the limited available water

Figure 7.—An area of Colvin silt loam, channeled. Meandering drainage channels dissect the landscape.

capacity are problems, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable salt-tolerant plants helps to control soil blowing. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil is suited to only a few of the most salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the reduced available water capacity caused by the salts in the soil. Reducing the evaporation rate at the surface improves seedling survival. If the surface is bare as the soil becomes dry, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIs. The productivity index for spring wheat is 22. The range site is Saline Lowland. The pasture group is Saline.

453—Colvin silt loam, wet. This very deep, level, very poorly drained, highly calcareous soil is in depressions on lake plains. It is subject to ponding. Individual areas range from about 4 to more than 50 acres in size.

Typically, the surface soil is black, calcareous silt loam about 12 inches thick. The subsoil is calcareous silt loam about 21 inches thick. It is gray in the upper part and light olive gray and mottled in the lower part. The substratum to a depth of about 60 inches is pale olive, mottled, calcareous silt loam. In an area west of Dunseith, the surface layer is peat and the subsoil and substratum are mucky peat.

Included with this soil in mapping are small areas of Southam soils and water. These areas make up about 5

percent of the unit. Southam soils have a substratum of silty clay loam or clay loam. They are in the deepest part of the depressions.

Permeability is moderately slow in the Colvin soil. Runoff is ponded. Available water capacity and organic matter content are high. A seasonal high water table is 1 foot above to 1 foot below the surface.

Most areas are used for wetland wildlife habitat. If drained, this soil generally is suited to small grain, flax, sunflowers, range, hay, and pasture. Suitable drainage outlets are not readily available. As a result, few areas are drained. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The main concern in managing cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. In undrained areas tillage, seeding, and harvesting are frequently delayed or prevented by wetness. The soil is occasionally dry enough for hay to be harvested.

The soil and the ponded water provide feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

In areas where this soil is used for range, the important forage plants are rivergrass, northern reedgrass, and slough sedge. In drained areas reed canarygrass and creeping foxtail are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed during wet periods. Grazing should be deferred when the soil is wet. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. In undrained areas, however, it is generally unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIw. The productivity index for spring wheat ranges from 10 to 57, depending on the degree of drainage. The range site is Wetland. In drained areas the pasture group is Wet.

470—Cresbard-Barnes loams, 0 to 3 percent slopes. These very deep, level and nearly level soils are on till plains. The moderately well drained, sodic Cresbard soil is in swales. The well drained Barnes soil is on rises. Individual areas range from about 8 to more than 100 acres in size. They are about 30 to 55 percent Cresbard soil and 25 to 50 percent Barnes soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Cresbard soil has a surface layer of black loam about 7 inches thick. The subsurface layer is very dark grayish brown loam about 2 inches thick. The next layer is very dark grayish brown clay loam about 2 inches thick. The subsoil is about 33 inches thick. It is somewhat dense. It is very dark grayish brown clay loam in the upper part, dark brown clay loam in the next part, and dark grayish brown, mottled, calcareous loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

Typically, the Barnes soil has a surface layer of black loam about 6 inches thick. The subsoil is loam about 26 inches thick. In sequence downward, it is very dark grayish brown, dark brown, yellowish brown and calcareous, and light olive brown and calcareous. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places it extends to a depth of only 4 to 6 inches.

Included with these soils in mapping are small areas of Cavour soils and the nonsaline and saline Hamerly soils. These included soils make up about 20 percent of the unit. Cavour soils have a sodic subsoil that is more dense than that of the Cresbard soil. They are intermingled with areas of the Cresbard soil. The nonsaline and saline Hamerly soils are somewhat poorly drained. They are on flats.

Permeability is slow in the Cresbard soil and moderately slow in the Barnes soil. Runoff is slow on both soils. Available water capacity is moderate in the Cresbard soil and high in the Barnes soil. Organic matter content is high in both soils. A seasonal high water table is at a depth of 4 to 6 feet in the Cresbard soil. The root zone is shallow in the Cresbard soil because of the dense, sodic subsoil. Tilth is fair in the Cresbard soil and good in the Barnes soil.

Most areas are used for cultivated crops. These soils are suited to small grain, flax, and sunflowers. The hazards of soil blowing and water erosion are slight. The main concern in managing cultivated areas is improving the penetration of roots in the dense, sodic

subsoil of the Cresbard soil. Crops growing on the Cresbard soil are characteristically stunted because of moisture stress. Local erosion can easily be controlled by a system of conservation tillage that leaves crop residue on the surface. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Growing deep-rooted crops, such as alfalfa, and managing crop residue increase the rate of water infiltration and improve tilth and the penetration of roots in the dense, sodic subsoil of the Cresbard soil.

Intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of these soils for pasture.

The Cresbard soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Barnes soil is suited to nearly all of the climatically adapted species. Individual trees and shrubs growing on the Cresbard soil vary in height, density, and vigor, which are affected by the restricted root development in the dense, sodic subsoil and the reduced available water capacity caused by the salts in the soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification of the Cresbard soil is IIIs, and that of the Barnes soil is IIc. The productivity index of the unit for spring wheat is 74. The range site of the Cresbard soil is Clayey, and that of the Barnes soil is Silty. The pasture group of the Cresbard soil is Clayey Subsoil, and that of the Barnes soil is Loamy and Silty.

501—Dickey-Esmond complex, 3 to 9 percent slopes. These very deep, well drained soils are on wind-sculptured till plains. The undulating Dickey soil is on side slopes. The undulating and gently rolling Esmond soil is on shoulder slopes and summits. Individual areas range from about 7 to more than 150 acres in size. They are about 45 to 70 percent Dickey soil and 15 to 40 percent Esmond soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Dickey soil has a surface layer of black loamy fine sand about 5 inches thick. The subsoil is about 41 inches thick. It is very dark grayish brown loamy fine sand in the upper part, dark brown fine sand in the next part, and light olive brown, calcareous loam in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In some areas the substratum is fine sand.

Typically, the Esmond soil has a surface layer of very dark gray, calcareous loam about 7 inches thick. The subsoil is calcareous loam about 19 inches thick. It is grayish brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is olive brown and calcareous. It is sandy loam in the upper part and loam in the lower part.

Included with these soils in mapping are small areas of the moderately well drained Swenoda soils in swales. These included soils make up about 10 percent of the unit.

Permeability is rapid in the upper part of the Dickey soil and moderate in the lower part. It is moderate in the Esmond soil. Runoff is slow on the Dickey soil and medium on the Esmond soil. Available water capacity is moderate in the Dickey soil and high in the Esmond soil. Organic matter content is moderately low in the Dickey soil and moderate in the Esmond soil. Tilth is fair in the Dickey soil and good in the Esmond soil.

Most areas are used for cultivated crops or hay. Some are used for range or pasture. Because the Dickey soil is droughty, it is very poorly suited to small grain, flax, and sunflowers. Rye or winter wheat makes the best use of the early season moisture supply and helps to control soil blowing in fall, winter, and spring. The hazard of soil blowing is severe on the Dickey soil and moderate on the Esmond soil. The hazard of water erosion is slight on the Dickey soil and moderate on the Esmond soil. The main concerns in managing cultivated areas are controlling soil blowing and water erosion and overcoming droughtiness. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome the droughtiness by trapping snow and thus increasing the moisture supply. Because of the low available water capacity, little benefit is derived from fallowing. Also, fallowing increases the susceptibility to soil blowing.

In areas where these soils are used for range, the important forage plants are prairie sandreed, sand bluestem, needleandthread, and little bluestem. Intermediate wheatgrass, pubescent wheatgrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control erosion. Denuding can occur along cattle trails. It can be prevented by a planned grazing system that controls the pattern of livestock traffic.

The Dickey soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Esmond soil is suited to only the most drought-tolerant species. Optimum

growth, survival, and vigor are unlikely on the Esmond soil. The Dickey soil is somewhat droughty. The trees and shrubs on this soil commonly are affected by moisture stress, particularly during the establishment period. Supplemental watering helps to ensure the survival of seedlings. Because of the low available water capacity, little benefit is derived from fallowing the season prior to planting. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of both soils is IVe. The productivity index of the unit for spring wheat is 37. The range site and pasture group of the Dickey soil are Sands, and those of the Esmond soil are Thin Upland.

502—Dickey-Esmond-Maddock complex, 9 to 25 percent slopes. These very deep, rolling and hilly, well drained soils are on wind-sculptured moraines. The Dickey and Maddock soils are on side slopes. The Esmond soil is on shoulder slopes and summits. Individual areas range from about 6 to more than 100 acres in size. They are about 20 to 45 percent Dickey soil, 15 to 40 percent Esmond soil, and 15 to 35 percent Maddock soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Dickey soil has a surface layer of black loamy fine sand about 5 inches thick. The subsoil is about 41 inches thick. It is very dark grayish brown loamy fine sand in the upper part, dark brown fine sand in the next part, and light olive brown, calcareous loam in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In some areas the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Esmond soil has a surface layer of very dark gray, calcareous loam about 7 inches thick. The subsoil is calcareous loam about 19 inches thick. It is grayish brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is olive brown and calcareous. It is sandy loam in the upper part and loam in the lower part.

Typically, the Maddock soil has a surface layer of very dark gray loamy fine sand about 6 inches thick. The subsoil is very dark grayish brown loamy fine sand about 7 inches thick. The next layer is brown fine sand about 20 inches thick. The substratum to a depth of about 60 inches also is brown fine sand.

Included with these soils in mapping are small areas of Swenoda soils and some areas of excessively drained soils. These included soils make up about 15 percent of the unit. Swenoda soils are moderately well drained. They are in swales. The excessively drained soils are on ridges.

Permeability is rapid in the upper part of the Dickey soil and moderate in the lower part. It is moderate in the Esmond soil and rapid in the Maddock soil. Runoff is slow on the Dickey and Maddock soils and rapid on the Esmond soil. Available water capacity is moderate in the Dickey soil, high in the Esmond soil, and low in the Maddock soil. Organic matter content is moderately low in the Dickey and Maddock soils and moderate in the Esmond soil.

Most areas are used for range or pasture. Because of the slope and a severe hazard of water erosion, these soils are generally unsuited to cultivated crops. The important forage plants in areas of range are prairie sandreed, sand bluestem, needleandthread, and little bluestem. Intermediate wheatgrass, pubescent wheatgrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control erosion. Denuding can occur along cattle trails. It can be prevented by a planned grazing system that controls the pattern of livestock traffic.

These soils are generally unsuited to the trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special treatment, such as hand or scalp planting, is applied.

The land capability classification of the three soils is VIIe. The productivity index of the unit for spring wheat is 0. The range site and pasture group of the Dickey and Maddock soils are Sands, and those of the Esmond soil are Thin Upland.

510—Divide loam. This very deep, level, somewhat poorly drained, highly calcareous soil is on flats and in swales and drainageways on outwash plains. Individual areas range from about 10 to more than 150 acres in size.

Typically, the surface layer is black, calcareous loam about 8 inches thick. The subsoil is about 17 inches thick. It is calcareous. It is gray and very dark gray loam in the upper part and olive gray, mottled gravelly loam in the lower part. The substratum to a depth of about 60 inches is olive and calcareous. It is gravelly sand in the upper part and mottled gravelly coarse sand in the lower part. In some areas the substratum is loam.

Included with this soil in mapping are small areas of the saline Divide soils and Renshaw soils. These soils make up about 15 percent of the unit. The saline Divide

soils are intermingled with areas of this Divide soil. Renshaw soils are somewhat excessively drained. They are on rises.

Permeability is moderate in the upper part of the Divide soil and very rapid in the lower part. Runoff is slow. Available water capacity is moderate. Organic matter content is high. A seasonal high water table is at a depth of 2.5 to 5.0 feet. The root zone is moderately deep because of the substratum of gravelly sand. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain, flax, and sunflowers. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The main concern in managing cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

Tall wheatgrass, switchgrass, big bluestem, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIs. The productivity index for spring wheat is 61. The range site and pasture group are Limy Subirrigated.

532—Eckman silt loam, 1 to 6 percent slopes. This very deep, nearly level and undulating, well drained soil is on flats and rises on lake plains. Individual areas range from about 8 to more than 100 acres in size.

Typically, the surface soil is silt loam about 11 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is silt loam about 21 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown and calcareous. It is very fine sandy loam in the upper part and loamy very fine sand in the lower part. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places it extends to a depth of only 4 to 6 inches.

Included with this soil in mapping are small areas of Egeland and Glyndon soils. These soils make up about 15 percent of the unit. Egeland soils contain more sand and less silt than the Eckman soil. They are intermingled with areas of the Eckman soil. Glyndon soils are somewhat poorly drained. They are on flats and in swales.

Permeability is moderate in the Eckman soil. Runoff is medium. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to small grain, flax, and sunflowers. The hazards of soil blowing and water erosion are slight, but soil blowing occurs during some storms. The main concern in managing cultivated areas is controlling localized soil blowing. Soil blowing can easily be controlled by a system of conservation tillage that leaves crop residue on the surface. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

Intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. No major problems affect the use of this soil for pasture. Maintaining an adequate cover of the suitable plants helps to control localized erosion.

This soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIe. The productivity index for spring wheat is 84. The range site is Silty. The pasture group is Loamy and Silty.

548—Egeland fine sandy loam, 0 to 6 percent slopes. This very deep, level to undulating, well drained soil is on flats and rises on lake plains. Individual areas range from about 7 to more than 100 acres in size.

Typically, the surface layer is black fine sandy loam about 8 inches thick. The subsoil is fine sandy loam about 25 inches thick. It is dark brown in the upper part and brown and calcareous in the lower part. The next layer is brown, calcareous loamy fine sand about 24 inches thick. The substratum to a depth of about 60 inches also is brown, calcareous loamy fine sand. In some areas the dark color of the surface layer extends to a depth of more than 16 inches.

Included with this soil in mapping are small areas of Maddock and Wyndmere soils. These soils make up about 20 percent of the unit. Maddock soils have a surface layer and subsoil of loamy fine sand. They are intermingled with areas of the Egeland soil. Wyndmere soils are somewhat poorly drained. They are in swales and on flats.

Permeability is moderately rapid in the Egeland soil. Runoff is slow. Available water capacity and organic matter content are moderate. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain, flax, and sunflowers. Rye or winter wheat makes the best use of the early season moisture supply and helps to control soil blowing in fall, winter, and spring. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The soil is somewhat droughty. The main concerns in managing cultivated areas are overcoming droughtiness and controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome the droughtiness by trapping snow and thus increasing the moisture supply.

Intermediate wheatgrass, pubescent wheatgrass, switchgrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants at a height that traps snow increases the moisture supply and helps to control soil blowing.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It is somewhat droughty, and the trees and shrubs commonly are affected by moisture stress, particularly during the establishment period. Supplemental watering helps to ensure the survival of seedlings. Because of the moderate available water capacity, little benefit is derived from fallowing the season prior to planting. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index for spring wheat is 63. The range site and pasture group are Sandy.

569—Embden fine sandy loam. This very deep, level, moderately well drained soil is on flats on lake plains. Individual areas range from about 5 to more than 25 acres in size.

Typically, the surface soil is black fine sandy loam about 16 inches thick. The subsoil is fine sandy loam about 27 inches thick. It is very dark grayish brown in the upper part, grayish brown and calcareous in the next part, and pale olive, mottled, and calcareous in the lower part. The substratum to a depth of about 60 inches is olive, mottled, calcareous loamy fine sand. In some places the dark color of the surface soil extends to a depth of only 8 to 16 inches. In other places the substratum is silt loam or loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Wyndmere soils in swales. These soils make up about 10 percent of the unit.

Permeability is moderately rapid in the Embden soil. Runoff is slow. Available water capacity is moderate. Organic matter content is high. A seasonal high water table is at a depth of 4 to 6 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to small grain, flax, and sunflowers. Rye or winter wheat makes the best use of the early season moisture supply and helps to control soil blowing in fall, winter, and spring. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The soil is slightly droughty. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome the droughtiness by trapping snow and thus increasing the moisture supply.

Intermediate wheatgrass, pubescent wheatgrass, switchgrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants at a height that traps snow increases the moisture supply and helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index for spring wheat is 74. The range site and pasture group are Sandy.

601—Eramosh peat. This very deep, level, very poorly drained soil is in moderately deep depressions on moraines and lake plains. It is subject to ponding. Individual areas range from about 4 to more than 60 acres in size.

Typically, the Eramosh soil has an organic surface soil about 15 inches thick. The organic surface soil is

black peat in the upper part and very dark gray mucky peat in the lower part. Below this is a mineral surface soil of very dark gray, calcareous silt loam about 17 inches thick. The substratum to a depth of about 60 inches is very dark gray, mottled, calcareous silt loam.

Included with this soil in mapping are small areas of the ponded Eramosh soils in the deepest parts of the depressions. These soils make up about 10 percent of the unit.

Permeability is moderate in the Eramosh soil. Runoff is ponded. Available water capacity and organic matter content are very high. A seasonal high water table is 2 feet above to 1 foot below the surface.

Most areas are used for range, hay, pasture, or wetland wildlife habitat. Because of ponding, this soil is generally unsuited to cultivated crops and to trees and shrubs. Suitable drainage outlets are not readily available. As a result, few areas are drained. The suitable range plants are northern reedgrass, slough sedge, and rivergrass. Reed canarygrass and creeping foxtail are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed during wet periods. Grazing should be deferred when the soil is wet.

The soil and the ponded water provide feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

The land capability classification is Vw. The productivity index for spring wheat is 0. The range site is Wetland. In drained areas the pasture group is Wet.

602—Eramosh peat, ponded. This very deep, level, very poorly drained soil is in deep depressions on moraines and lake plains. It is subject to ponding. Individual areas range from about 4 to more than 25 acres in size.

Typically, the Eramosh soil has an organic surface soil about 15 inches thick. The organic surface soil is black peat in the upper part and very dark gray mucky peat in the lower part. Below this is a mineral surface soil of very dark gray, calcareous silt loam about 17 inches thick. The substratum to a depth of about 60 inches is very dark gray, mottled, calcareous silt loam.

Included with this soil in mapping are small areas of water. These areas make up about 10 percent of the unit.

Permeability is moderate in the Eramosh soil. Runoff is ponded. Available water capacity and organic matter content are very high. A seasonal high water table is 2 feet above to 1 foot below the surface.

Most areas of this soil are used for wetland wildlife habitat. The soil is best suited to this use. Because of the ponding, it is generally unsuited to cultivated crops, hay, pasture, and trees and shrubs. Suitable drainage outlets are not readily available. As a result, few areas are drained. The soil and the ponded water provide excellent winter cover for resident wildlife and high-quality feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

The land capability classification is VIIIw. The productivity index for spring wheat is 0. No range site or pasture group is assigned.

605—Esmond-Heimdal loams, 9 to 15 percent slopes. These very deep, rolling, well drained soils are on moraines. The Esmond soil is on shoulder slopes and summits. The Heimdal soil is on side slopes. Individual areas range from about 5 to more than 70 acres in size. They are about 25 to 50 percent Esmond soil and 25 to 45 percent Heimdal soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Esmond soil has a surface layer of very dark gray, calcareous loam about 7 inches thick. The subsoil is calcareous loam about 19 inches thick. It is grayish brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is olive brown and calcareous. It is sandy loam in the upper part and loam in the lower part. In some areas the dark color of the surface layer extends to a depth of only 3 to 5 inches.

Typically, the Heimdal soil has a surface layer of black loam about 8 inches thick. The subsoil is loam about 24 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, calcareous loam. In some areas the surface layer and subsoil are fine sandy loam.

Included with these soils in mapping are small areas of Arvilla, Dickey, and Emrick soils. These included soils make up about 25 percent of the unit. Arvilla and Dickey soils are intermingled with areas of the Heimdal soil. Arvilla soils are sandy loam in the surface layer and in the upper part of the subsoil and have a substratum of gravelly coarse sand. Dickey soils are loamy fine sand in the surface layer and in the upper part of the subsoil. Emrick soils are moderately well drained. They are in swales.

Permeability is moderate in the Esmond and Heimdal soils. Runoff is rapid. Available water capacity is high. Organic matter content is moderate in the Esmond soil and high in the Heimdal soil.

Most areas are used for cultivated crops. Because of the slope and a severe hazard of water erosion, these

soils are generally unsuited to small grain and flax. They are best suited to range, hay, and pasture. Converting cultivated areas to range or pasture helps to control erosion.

In areas where these soils are used for range, the important forage plants are western wheatgrass, needleandthread, green needlegrass, and little bluestem. Intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Esmond soil is generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. The Heimdal soil is suited to nearly all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification of the Esmond soil is VIe, and that of the Heimdal soil is IVe. The productivity index of the unit for spring wheat is 0. The range site of the Esmond soil is Thin Upland, and that of the Heimdal soil is Silty. The pasture group of the Esmond soil is Thin Upland, and that of the Heimdal soil is Loamy and Silty.

607—Esmond-Heimdal loams, 15 to 25 percent slopes. These very deep, hilly, well drained soils are on moraines. The Esmond soil is on shoulder slopes and summits. The Heimdal soil is on side slopes. Individual areas range from about 8 to more than 70 acres in size. They are about 30 to 55 percent Esmond soil and 25 to 50 percent Heimdal soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Esmond soil has a surface layer of very dark gray, calcareous loam about 7 inches thick. The subsoil is calcareous loam about 19 inches thick. It is grayish brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is olive brown and calcareous. It is sandy loam in the upper part and loam in the lower part. In some areas the dark color of the surface layer extends to a depth of only 3 to 5 inches.

Typically, the Heimdal soil has a surface layer of black loam about 8 inches thick. The subsoil is loam about 24 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, calcareous loam. In some areas the surface layer and subsoil are fine sandy loam.

Included with these soils in mapping are small areas of Emrick and Towner soils. These included soils make up about 15 percent of the unit. They are in swales. Emrick soils are moderately well drained. Towner soils have a surface layer and subsoil of loamy fine sand.

Permeability is moderate in the Esmond and Heimdal soils. Runoff is very rapid. Available water capacity is high. Organic matter content is moderate in the Esmond soil and high in the Heimdal soil.

Most areas are used for range, hay, or pasture. Because of the slope and a severe hazard of water erosion, these soils are generally unsuited to cultivated crops. The important forage plants in areas of range are western wheatgrass, needleandthread, green needlegrass, and little bluestem. Intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

These soils are generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

The land capability classification of the Esmond soil is VIIe, and that of the Heimdal soil is VIe. The productivity index of the unit for spring wheat is 0. The range site of the Esmond soil is Thin Upland, and that of the Heimdal soil is Silty. The pasture group of the Esmond soil is Thin Upland, and that of the Heimdal soil is Loamy and Silty.

768—Gardena silt loam. This very deep, level, moderately well drained soil is on flats on lake plains. Individual areas range from about 5 to more than 100 acres in size.

Typically, the surface soil is black silt loam about 16 inches thick. The subsoil is silt loam about 17 inches thick. It is very dark brown in the upper part, very dark grayish brown in the next part, and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous very fine

sandy loam. It is mottled between depths of 33 and 51 inches. In some areas the dark color of the surface layer extends to a depth of only 7 to 16 inches.

Included with this soil in mapping are small areas of Glyndon soils. These soils make up about 10 percent of the unit. They are somewhat poorly drained. They are in swales.

Permeability is moderate in the Gardena soil. Runoff is slow. Available water capacity and organic matter content are high. A seasonal high water table is at a depth of 4 to 6 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to small grain, flax, and sunflowers. The hazards of soil blowing and water erosion are slight, but soil blowing occurs during some storms. The main concern in managing cultivated areas is controlling localized soil blowing. Soil blowing can be easily controlled by a system of conservation tillage that leaves crop residue on the surface. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

Intermediate wheatgrass, pubescent wheatgrass, switchgrass, and alfalfa are suitable hay and pasture plants. No major problems affect the use of this soil for pasture. Maintaining an adequate cover of the suitable plants helps to control localized erosion.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIe. The productivity index for spring wheat is 99. The range site is Silty. The pasture group is Loamy and Silty.

800—Glyndon silt loam. This very deep, level, somewhat poorly drained, highly calcareous soil is on flats and in swales on lake plains. Individual areas range from about 7 to more than 100 acres in size.

Typically, the surface layer is black, calcareous silt loam about 7 inches thick. The subsoil is mottled, calcareous silt loam about 22 inches thick. It is olive gray in the upper part and olive in the lower part. The next layer is olive, mottled silt loam about 15 inches thick. The substratum to a depth of about 60 inches is mottled silt loam. It is olive in the upper part and olive gray and olive brown in the lower part. In some areas the soil has a layer of lime accumulation below a depth of 16 inches.

Included with this soil in mapping are small areas of Aberdeen soils, the saline Glyndon soils, and Wyndmere soils. These soils make up about 15 percent of the unit. Aberdeen soils have a sodic subsoil. They are on rises. Glyndon and Wyndmere soils are intermingled with areas of the Glyndon soil. The saline Glyndon soils have salts throughout. Wyndmere soils have a surface layer and subsoil of fine sandy loam and a substratum of loamy fine sand.

Permeability is moderate in the Glyndon soil. Runoff is slow. Available water capacity and organic matter content are high. A seasonal high water table is at a depth of 2.5 to 6.0 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to small grain, flax, and sunflowers. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The main concern in managing cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

Tall wheatgrass, smooth bromegrass, big bluestem, and birdsfoot trefoil are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIe. The productivity index for spring wheat is 91. The range site and pasture group are Limy Subirrigated.

846—Great Bend-Overly silt loams, 0 to 3 percent slopes. These very deep, level and nearly level soils are on lake plains. The well drained Great Bend soil is on rises. The moderately well drained Overly soil is in swales. Individual areas range from about 10 to more than 150 acres in size. They are about 30 to 55 percent Great Bend soil and 25 to 50 percent Overly soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Great Bend soil has a surface layer of black silt loam about 8 inches thick. The subsoil is about 18 inches thick. It is very dark grayish brown silty clay loam in the upper part and yellowish brown, calcareous silt loam in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous silt loam in the upper part and olive brown

silty clay loam in the lower part.

Typically, the Overly soil has a surface soil of black silt loam about 14 inches thick. The subsoil is about 14 inches thick. It is very dark grayish brown silty clay loam in the upper part and grayish brown, calcareous silt loam in the lower part. The substratum to a depth of about 60 inches is calcareous. It is light olive brown silt loam in the upper part and olive brown, mottled silty clay loam in the lower part.

Included with these soils in mapping are small areas of Aberdeen and Bearden soils. These included soils make up about 20 percent of the unit. Aberdeen soils have a sodic subsoil. They are intermingled with areas of the Overly soil. Bearden soils are somewhat poorly drained. They are on flats.

Permeability is moderately slow in the Great Bend and Overly soils. Runoff is slow. Available water capacity and organic matter content are high. A seasonal high water table is at a depth of 4 to 6 feet in the Overly soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are well suited to small grain, flax, and sunflowers. The hazards of soil blowing and water erosion are slight. The main concern in managing cultivated areas is maintaining fertility and tilth. Adding organic material to the surface layer helps to maintain fertility and tilth. Localized erosion can be easily controlled by a system of conservation tillage that leaves crop residue on the surface. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

Intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of these soils for pasture.

The Great Bend soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Overly soil is suited to all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification of both soils is IIc. The productivity index of the unit for spring wheat is 93. The range site of both soils is Silty. The pasture group of both soils is Loamy and Silty.

863—Hamerly loam, 0 to 3 percent slopes. This very deep, level and nearly level, somewhat poorly drained, highly calcareous soil is on flats on till plains. Individual areas range from about 5 to more than 50 acres in size.

Typically, the surface layer is black, calcareous loam about 7 inches thick. The subsoil is mottled, calcareous loam about 22 inches thick. It is light brownish gray in the upper part and light yellowish brown in the lower part. The next layer is light olive brown, mottled, calcareous loam about 5 inches thick. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In some areas the soil has a layer of lime accumulation below a depth of 16 inches.

Included with this soil in mapping are small areas of the saline Hamerly soils. These soils make up about 10 percent of the unit. They are intermingled with areas of this Hamerly soil.

Permeability is moderately slow in the Hamerly soil. Runoff is slow. Available water capacity and organic matter content are high. A seasonal high water table is at a depth of 2 to 4 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to small grain, flax, and sunflowers. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The main concern in managing cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

Tall wheatgrass, smooth bromegrass, big bluestem, and birdsfoot trefoil are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIe. The productivity index for spring wheat is 82. The range site and pasture group are Limy Subirrigated.

864—Hamerly loam, saline, 0 to 3 percent slopes. This very deep, level and nearly level, somewhat poorly drained, highly calcareous, moderately saline soil is on flats on till plains. Individual areas range from about 5 to more than 50 acres in size.

Typically, the surface layer is black, calcareous loam about 7 inches thick. It has an accumulation of salts. The subsoil is mottled, calcareous loam about 22 inches thick. It is light brownish gray in the upper part and light yellowish brown in the lower part. The next layer is light olive brown, mottled, calcareous loam about 5 inches

thick. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In some areas the soil is nonsaline.

Included with this soil in mapping are small areas of the moderately well drained Cresbard soils on rises. These soils make up about 10 percent of the unit.

Permeability is moderately slow in the Hamerly soil. Runoff is slow. Available water capacity is moderate. The salts in the soil reduce the amount of water available to plants. Organic matter content is high. A seasonal high water table is at a depth of 2 to 4 feet. Tilth is good.

Most areas are used for cultivated crops. Because of the salinity, this soil is poorly suited to small grain, flax, and sunflowers. It is best suited to salt-tolerant crops, hay, and pasture. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The main concerns in managing cultivated areas are controlling soil blowing and overcoming salinity. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. A permanent cover of crops helps to control the accumulation of salts in the surface layer by reducing the evaporation rate at the surface.

Tall wheatgrass, slender wheatgrass, alsike clover, and sweetclover are suitable hay and pasture plants. Soil blowing is a hazard. The high content of salts and the reduced available water capacity are problems, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil is suited to only a few of the most salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the reduced available water capacity caused by the salts in the soil. Reducing the evaporation rate at the surface improves seedling survival. If the surface is bare as the soil becomes dry, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIs. The productivity index for spring wheat is 50. The range site is Saline Lowland. The pasture group is Saline.

883—Hamerly-Tonka-Parnell complex, 0 to 3 percent slopes. These very deep soils are on till plains. The level and nearly level, somewhat poorly drained, highly calcareous Hamerly soil is on flats. The level, poorly drained Tonka soil is in shallow depressions. The level, very poorly drained Parnell soil is in moderately deep depressions. The Tonka and Parnell soils are subject to ponding. Individual areas range from about 7 to more than 150 acres in size. They are about 40 to 65 percent Hamerly soil, 15 to 35 percent Tonka soil, and 10 to 30 percent Parnell soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Hamerly soil has a surface layer of black, calcareous loam about 7 inches thick. The subsoil is mottled, calcareous loam about 22 inches thick. It is light brownish gray in the upper part and light yellowish brown in the lower part. The next layer is light olive brown, mottled, calcareous loam about 5 inches thick. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In some areas the soil has a layer of lime accumulation below a depth of 16 inches.

Typically, the Tonka soil has a surface layer of black silt loam about 7 inches thick. The subsurface layer is dark gray, mottled loam about 7 inches thick. The subsoil is silty clay loam about 20 inches thick. It is black in the upper part and dark olive gray and mottled in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled loam. In some areas the soil has an accumulation of lime within a depth of 16 inches.

Typically, the Parnell soil has a surface soil of black silt loam about 11 inches thick. The subsoil is silty clay loam about 26 inches thick. It is black in the upper part and dark olive gray and mottled in the lower part. The substratum to a depth of about 60 inches is olive gray and mottled. It is loam in the upper part and calcareous clay loam in the lower part.

Included with these soils in mapping are small areas of Barnes soils and the saline Hamerly soils. These included soils make up about 10 percent of the unit. Barnes soils are well drained. They are on rises. The saline Hamerly soils are on flats.

Permeability is moderately slow in the Hamerly soil and slow in the Tonka and Parnell soils. Runoff is slow on the Hamerly soil and ponded on the Tonka and Parnell soils. Available water capacity and organic matter content are high in all three soils. A seasonal high water table is at a depth of 2.0 to 4.0 feet in the Hamerly soil, is 0.5 foot above to 1.0 foot below the surface of the Tonka soil, and is 2.0 feet above to 2.0 feet below the surface of the Parnell soil. Tilth is good in all three soils.

Most areas are used for cultivated crops. The Hamerly soil is well suited to small grain, flax, and sunflowers. Drained areas of the Parnell and Tonka

soils are suited to those crops. Suitable drainage outlets are not readily available. As a result, few areas of the Parnell and Tonka soils are drained. In undrained areas of these soils, tillage, seeding, and harvesting are frequently delayed or prevented by ponded surface water. Crops are harvested in only about 1 or 2 years out of 10 on the Parnell soil and 5 to 7 years out of 10 on the Tonka soil. The hazard of soil blowing is moderate on the Hamerly soil and slight on the Parnell and Tonka soils. The hazard of water erosion is slight on all three soils. The main concerns in managing cultivated areas are controlling soil blowing and overcoming wetness. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. A surface drainage system improves the suitability for crops.

The Tonka soil and the ponded water provide breeding sites and high-quality invertebrate protein for wetland wildlife. The Parnell soil and the ponded water provide feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

Tall wheatgrass, smooth bromegrass, reed canarygrass, switchgrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard on the Hamerly soil, especially if the pasture is overgrazed. Compaction, trampling, and root shearing are problems on the Tonka and Parnell soils, especially if the pasture is grazed during wet periods. Grazing should be deferred when the soils are wet. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

The Hamerly soil and drained areas of the Tonka and Parnell soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas of the Tonka and Parnell soils, however, are generally unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on the Tonka and Parnell soils are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Hamerly soil is IIe, that of the Tonka soil is IIw, and that of the Parnell soil is IIIw. The productivity index of the unit for spring wheat ranges from 61 to 81, depending on the degree of drainage in areas of the Tonka and Parnell soils. The range site of the Hamerly soil is Limy Subirrigated, that of the Tonka soil is Wet Meadow, and that of the Parnell soil is Wetland. The pasture group of the Hamerly soil is Limy Subirrigated, that of the Tonka soil is Wet, and that of the Parnell soil is Wet in drained areas.

893—Harriet silt loam. This very deep, level, poorly drained, sodic, strongly saline soil is on flats on bottom land. It is occasionally flooded. Individual areas range from about 6 to more than 200 acres in size.

Typically, the surface layer is very dark gray silt loam about 2 inches thick. The subsoil is silty clay loam about 47 inches thick. It is very dark gray in the upper part, black in the next part, and olive gray, mottled, and calcareous in the lower part. The substratum to a depth of about 60 inches is olive gray silty clay loam.

Included with this soil in mapping are small areas of Aberdeen and Nahon soils. These soils make up about 10 percent of the unit. They are moderately well drained. They are on flats and rises.

Permeability is very slow in the Harriet soil. Runoff is slow. Available water capacity is moderate. The salts in the soil reduce the amount of water available to plants. Organic matter content is high. A seasonal high water table is within a depth of 1 foot. The root zone is very shallow because of the dense, sodic subsoil.

Most areas are used for range, hay, or pasture. Because of the dense, sodic subsoil and the salts, this soil is generally unsuited to cultivated crops and to trees and shrubs. In areas where the soil is used for range, the important forage plants are inland saltgrass, alkali cordgrass, and Nuttall alkaligrass. Tall wheatgrass, beardless wildrye, western wheatgrass, and sweetclover are suitable hay and pasture plants. The dense sodic subsoil, which restricts root penetration, and the salts, which reduce the amount of water available to plants, are problems, especially if the pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the suitable plants helps to prevent denuding. Stock water ponds constructed in areas of this soil frequently contain salty water.

The land capability classification is VIs. The productivity index for spring wheat is 0. The range site is Saline Lowland. The pasture group is Sodic and Saline.

926—Hecla loamy fine sand, 0 to 3 percent slopes. This very deep, level and nearly level, moderately well drained soil is on flats on wind-sculptured lake plains. Individual areas range from about 10 to more than 250 acres in size.

Typically, the surface soil is black loamy fine sand about 20 inches thick. The next layer is very dark grayish brown loamy fine sand about 6 inches thick. The substratum to a depth of about 60 inches is mottled. It is brown fine sand in the upper part and grayish brown, calcareous loamy fine sand in the lower part. In some areas the substratum is loam or silt loam below a depth of 40 inches.

Included with this soil in mapping are small areas of Embden, Hamar, and Maddock soils. These soils make up about 15 percent of the unit. Embden soils have a surface layer and subsoil of fine sandy loam. They are intermingled with areas of the Hecla soil. Hamar soils are somewhat poorly drained. They are in swales. Maddock soils are well drained. They are on rises.

Permeability is rapid in the Hecla soil. Runoff is slow. Available water capacity is low. Organic matter content is moderately low. A seasonal high water table is at a depth of 3 to 6 feet. Tilth is fair.

Most areas are used for cultivated crops, range, pasture, or hay. Because of droughtiness, this soil is poorly suited to small grain, flax, and sunflowers. Rye or winter wheat makes the best use of the early season moisture supply and helps to control soil blowing in fall, winter, and spring. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome the droughtiness by trapping snow and thus increasing the moisture supply. Because of the low available water capacity, little benefit is derived from fallowing. Also, fallowing increases the susceptibility to soil blowing.

In areas where this soil is used for range, the important forage plants are prairie sandreed, needleandthread, and sand bluestem. Intermediate wheatgrass, pubescent wheatgrass, sand bluestem, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants at a height that traps snow increases the moisture supply and helps to control soil blowing. Denuding can occur along cattle trails. It can be prevented by a planned grazing system that controls the pattern of livestock traffic.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IVe. The productivity index for spring wheat is 51. The range site and pasture group are Sands.

939—Hecla-Hamar loamy fine sands, 0 to 3 percent slopes. These very deep, level and nearly level soils are on wind-sculptured lake plains. The moderately well drained Hecla soil is on flats. The somewhat poorly drained Hamar soil is in swales. Individual areas range from about 7 to more than 100 acres in size. They are about 40 to 65 percent Hecla soil and 35 to 60 percent Hamar soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Hecla soil has a surface soil of black loamy fine sand about 20 inches thick. The next layer is very dark grayish brown loamy fine sand about 6 inches thick. The substratum to a depth of about 60 inches is mottled. It is brown fine sand in the upper part and grayish brown, calcareous loamy fine sand in the lower part.

Typically, the Hamar soil has a surface soil of black loamy fine sand about 12 inches thick. The next layer is very dark gray, mottled fine sand about 5 inches thick. The substratum to a depth of about 60 inches is mottled fine sand. It is dark gray in the upper part and olive gray and calcareous in the lower part. In some areas the soil has a layer of lime accumulation within a depth of 16 inches.

Included with these soils in mapping are small areas of the well drained Maddock soils on rises. These included soils make up about 5 percent of the unit.

Permeability is rapid in the Hecla and Hamar soils. Runoff is slow. Available water capacity is low. Organic matter content is moderately low. A seasonal high water table is at a depth of 3 to 6 feet in the Hecla soil and within a depth of to 2 feet in the Hamar soil. Tilth is fair in both soils.

Most areas are used for cultivated crops, range, pasture, or hay. These soils are poorly suited to small grain, flax, and sunflowers. Rye or winter wheat makes the best use of the early season moisture supply and helps to control soil blowing in fall, winter, and spring. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips,

and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow and thus increasing the moisture supply. Because of the low available water capacity, little benefit is derived from fallowing. Also, fallowing increases the susceptibility to soil blowing.

In areas where these soils are used for range, the important forage plants are prairie sandreed, sand bluestem, big bluestem, and switchgrass. Intermediate wheatgrass, creeping foxtail, sand bluestem, big bluestem, alfalfa, and alsike clover are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants at a height that traps snow increases the moisture supply and helps to control soil blowing. Denuding can occur along cattle trails. It can be prevented by a planned grazing system that controls the pattern of livestock traffic.

The Hecla soil and drained areas of the Hamar soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas of the Hamar soil, however, are generally unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on the Hamar soil are abundant and persistent. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Hecla soil is IVe, and that of the Hamar soil is IVw. The productivity index of the unit for spring wheat is 50. The range site of the Hecla soil is Sands, and that of the Hamar soil is Subirrigated. The pasture group of the Hecla soil is Sands, and that of the Hamar soil is Wet.

987—Heimdal-Emrick loams, 0 to 3 percent slopes. These very deep, level and nearly level soils are on till plains. The well drained Heimdal soil is on flats and rises. The moderately well drained Emrick soil is in swales. Individual areas range from about 5 to more than 100 acres in size. They are about 45 to 70 percent Heimdal soil and 25 to 50 percent Emrick soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Heimdal soil has a surface layer of black loam about 8 inches thick. The subsoil is loam about 24 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, calcareous loam. In some areas the dark color of the surface layer extends to a depth of only 4 to 6 inches.

Typically, the Emrick soil has a surface layer of black loam about 7 inches thick. The subsoil is loam about 39 inches thick. It is very dark grayish brown in the upper part, dark brown in the next part, and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous loam.

Included with these soils in mapping are small areas of Cathay soils. These included soils make up about 5 percent of the unit. They have a sodic subsoil. They are intermingled with areas of the Emrick soil.

Permeability is moderate in the Heimdal and Emrick soils. Runoff is slow. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. These soils are well suited to small grain, flax, and sunflowers. The hazards of soil blowing and water erosion are slight, but soil blowing occurs during some storms. The main concern in managing cultivated areas is controlling localized soil blowing. Soil blowing can be easily controlled by a system of conservation tillage that leaves crop residue on the surface. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. No major problems affect the use of these soils for hay or pasture. Maintaining an adequate cover of the suitable plants helps to control localized erosion.

The Heimdal soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Emrick soil is suited to all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification of both soils is IIe. The productivity index of the unit for spring wheat is 82. The range site of the Heimdal soil is Silty, and that of the Emrick soil is Overflow. The pasture group of the Heimdal soil is Loamy and Silty, and that of the Emrick soil is Overflow and Run-on.

992—Heimdal-Emrick-Esmond loams, 3 to 6 percent slopes. These very deep, undulating soils are on till plains. The well drained Heimdal soil is on flats and rises. The moderately well drained Emrick soil is in

swales. The well drained Esmond soil is on knolls. Individual areas range from about 5 to more than 150 acres in size. They are about 40 to 65 percent Heimdal soil, 15 to 35 percent Emrick soil, and 15 to 35 percent Esmond soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Heimdal soil has a surface layer of black loam about 8 inches thick. The subsoil is loam about 24 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, calcareous loam. In some areas the surface layer and subsoil are fine sandy loam.

Typically, the Emrick soil has a surface layer of black loam about 7 inches thick. The subsoil is loam about 39 inches thick. It is very dark grayish brown in the upper part, dark brown in the next part, and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In some areas the surface layer and subsoil are fine sandy loam.

Typically, the Esmond soil has a surface layer of very dark gray loam about 7 inches thick. The subsoil is loam about 19 inches thick. It is grayish brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is olive brown. It is sandy loam in the upper part and loam in the lower part.

Included with these soils in mapping are small areas of the well drained Dickey soils. These included soils make up about 5 percent of the unit. They are loamy fine sand in the surface layer and in the upper part of the subsoil. They are intermingled with areas of the Heimdal soil.

Permeability is moderate in the Heimdal, Emrick, and Esmond soils. Runoff is medium on the Heimdal and Esmond soils and slow on the Emrick soil. Available water capacity is high in all three soils. Organic matter content is high in the Heimdal and Emrick soils and moderate in the Esmond soil. Tilth is good in all three soils.

Most areas are used for cultivated crops. These soils are suited to small grain, flax, and sunflowers. The hazard of soil blowing is slight on the Heimdal and Emrick soils and moderate on the Esmond soil. The hazard of water erosion is moderate on all three soils. The main concern in managing cultivated areas is controlling water erosion and soil blowing. A system of conservation tillage that leaves crop residue on the surface, stripcropping, grassed waterways in areas where runoff concentrates, and field windbreaks help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

Intermediate wheatgrass, smooth bromegrass, big bluestem, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control erosion.

The Heimdal soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Emrick soil is suited to all of the climatically adapted species. The Esmond soil is suited to only the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on the Esmond soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Heimdal and Emrick soils is IIe, and that of the Esmond soil is IIIe. The productivity index of the unit for spring wheat is 66. The range site of the Heimdal and Emrick soils is Silty, and that of the Esmond soil is Thin Upland. The pasture group of the Heimdal and Emrick soils is Loamy and Silty, and that of the Esmond soil is Thin Upland.

998—Heimdal-Esmond loams, 6 to 9 percent slopes. These very deep, gently rolling, well drained soils are on till plains. The Heimdal soil is on side slopes and summits. The Esmond soil is on knolls, ridges, and shoulder slopes. Individual areas range from about 5 to more than 100 acres in size. They are about 55 to 75 percent Heimdal soil and 15 to 40 percent Esmond soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Heimdal soil has a surface layer of black loam about 8 inches thick. The subsoil is loam about 24 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, calcareous loam. In some areas the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Esmond soil has a surface layer of very dark gray, calcareous loam about 7 inches thick. The subsoil is calcareous loam about 19 inches thick. It is grayish brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is olive brown and calcareous. It is sandy loam

in the upper part and loam in the lower part.

Included with these soils in mapping are small areas of Dickey soils. These included soils make up about 5 percent of the unit. They are loamy fine sand in the surface layer and in the upper part of the subsoil. They are intermingled with areas of the Heimdal soil.

Permeability is moderate in the Heimdal and Esmond soils. Runoff is medium. Available water capacity is high. Organic matter content is high in the Heimdal soil and moderate in the Esmond soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to small grain and flax. The hazard of soil blowing is slight on the Heimdal soil and moderate on the Esmond soil. The hazard of water erosion is moderate on both soils. The main concern in managing cultivated areas is controlling water erosion and soil blowing. A system of conservation tillage that leaves crop residue on the surface, stripcropping, grassed waterways in areas where runoff concentrates, and field windbreaks help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

Intermediate wheatgrass, smooth bromegrass, switchgrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Heimdal soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Esmond soil is suited to only the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on the Esmond soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Heimdal soil is IIIe, and that of Esmond soil is IVe. The productivity index of the unit for spring wheat is 48. The range site of the Heimdal soil is Silty, and that of the Esmond soil is Thin Upland. The pasture group of the Heimdal soil is Loamy and Silty, and that of the Esmond soil is Thin Upland.

1013—Kelvin loam, 3 to 9 percent slopes. This very deep, undulating and gently rolling, well drained soil is on side slopes on till plains. Individual areas range from about 10 to more than 700 acres in size.

Typically, the surface layer is dark grayish brown and very dark grayish brown loam about 4 inches thick. It is covered by a 2-inch layer of organic material. The subsoil is about 35 inches thick. It is dark grayish brown. It is clay in the upper part and calcareous clay loam in the lower part. The substratum to a depth of about 60 inches is brown, calcareous clay loam.

Included with this soil in mapping are small areas of the very poorly drained Eramosh soils in depressions. These soils make up about 5 percent of the unit.

Permeability is moderately slow in the Kelvin soil. Runoff is medium. Available water capacity is high. Organic matter content is moderate. Tilth is good.

Most areas are used for cultivated crops. Some areas of native woodland are used for pasture and wildlife habitat. This soil is suited to small grain and flax. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. The main concern in managing cultivated areas is controlling water erosion. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and grassed waterways in areas where runoff concentrates help to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

Intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Water erosion is a problem, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

This soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIIe. The productivity index for spring wheat is 67. No range site is assigned. The pasture group is Loamy and Silty.

1014—Kelvin loam, 9 to 25 percent slopes. This very deep, rolling and hilly, well drained soil is on side slopes and summits on till plains and moraines. Individual areas range from about 15 to more than 1,000 acres in size.

Typically, the surface layer is dark grayish brown and very dark grayish brown loam about 4 inches thick. It is covered by a 2-inch layer of organic material. The subsoil is about 35 inches thick. It is dark grayish brown. It is clay in the upper part and calcareous clay

loam in the lower part. The substratum to a depth of about 60 inches is brown, calcareous clay loam.

Included with this soil in mapping are small areas of Eramosh and Metigoshe soils. These soils make up about 5 percent of the unit. Eramosh soils are very poorly drained. They are in depressions. Metigoshe soils have a surface layer and subsoil of sandy loam and a substratum of gravelly sand. They are intermingled with areas of the Kelvin soil.

Permeability is moderately slow in the Kelvin soil. Runoff is rapid. Available water capacity is high. Organic matter content is moderate.

Most of the acreage is native woodland used for pasture and wildlife habitat. Some areas are used for cultivated crops or hay. Because of the slope and a severe hazard of water erosion, this soil is generally unsuited to cultivated crops. Converting cultivated areas to range or pasture helps to control erosion.

Intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

This soil is generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

The land capability classification is VIe. The productivity index for spring wheat is 0. No range site is assigned. The pasture group is Loamy and Silty.

1104—Lanona-Swenoda fine sandy loams, 1 to 6 percent slopes. These very deep soils are on till plains. The nearly level and undulating, well drained Lanona soil is on flats and rises. The nearly level, moderately well drained Swenoda soil is on flats and in swales. Individual areas range from about 10 to more than 100 acres in size. They are about 40 to 65 percent Lanona soil and 25 to 50 percent Swenoda soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Lanona soil has a surface layer of black fine sandy loam about 9 inches thick. The subsoil is fine sandy loam about 20 inches thick. It is dark brown in the upper part and light brownish gray in the lower part. It is calcareous between depths of 14 and 29 inches. The substratum to a depth of about 60 inches is olive brown, calcareous clay loam. In some areas the substratum is fine sandy loam.

Typically, the Swenoda soil has a surface soil of black fine sandy loam about 12 inches thick. The subsoil is about 26 inches thick. It is very dark grayish brown fine sandy loam in the upper part, dark brown fine sandy loam in the next part, and light olive brown, mottled, calcareous loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In some areas the substratum is fine sandy loam.

Included with these soils in mapping are small areas of Dickey and Wyndmere soils. These included soils make up about 10 percent of the unit. Dickey soils are loamy fine sand in the surface layer and in the upper part of the subsoil. They are intermingled with areas of the Lanona soil. Wyndmere soils are somewhat poorly drained. They are on flats.

Permeability is moderately rapid in the upper part of the Swenoda and Lanona soils and moderately slow in the lower part. Runoff is slow. Available water capacity and organic matter content are high. A seasonal high water table is at a depth of 2.5 to 4.0 feet in the Swenoda soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are well suited to small grain, flax, and sunflowers. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main concern in managing cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

Intermediate wheatgrass, pubescent wheatgrass, switchgrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

The Lanona soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Swenoda soil is suited to all of the climatically adapted species. The Lanona soil is somewhat droughty. The trees and shrubs on this soil commonly are affected by moisture stress, particularly during the establishment period. Supplemental watering helps to ensure the survival of seedlings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of both soils is IIIe.

The productivity index of the unit for spring wheat is 68. The range site and pasture group of both soils are Sandy.

1140—Letcher fine sandy loam, 0 to 6 percent slopes. This very deep, level to undulating, moderately well drained, sodic soil is on flats and rises on outwash plains. Individual areas range from about 5 to more than 50 acres in size.

Typically, the surface layer is black fine sandy loam about 8 inches thick. The subsurface layer is very dark grayish brown loamy fine sand about 5 inches thick. The subsoil is about 27 inches thick. In sequence downward, it is very dark grayish brown sandy loam; dark brown sandy loam; yellowish brown, calcareous loam; and brown, calcareous loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. In some areas the subsoil is loam throughout.

Included with this soil in mapping are small areas of Stirum, Swenoda, and Wyndmere soils. These soils make up about 25 percent of the unit. Stirum soils are poorly drained. They are in swales. Swenoda soils do not have a sodic subsoil. They are intermingled with areas of the Letcher soil. Wyndmere soils are somewhat poorly drained. They are in swales.

Permeability is slow in the upper part of the Letcher soil and moderate in the lower part. Runoff is slow. Available water capacity is low. Organic matter content is moderate. A seasonal high water table is at a depth of 3.5 to 6.0 feet. The root zone is shallow because of the dense, sodic subsoil. Tilth is poor.

Most areas are used for cultivated crops or hay. Because of the dense, sodic subsoil, this soil is very poorly suited to small grain, flax, and sunflowers. Rye or winter wheat makes the best use of the early season moisture supply and helps to control soil blowing in fall, winter, and spring. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main concerns in managing cultivated areas are controlling soil blowing and improving tilth and root penetration in the dense, sodic subsoil. Crops growing in this soil are characteristically stunted because of moisture stress. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Growing alfalfa and managing crop residue improve tilth, increase the rate of water infiltration, and improve the penetration of roots in the dense, sodic subsoil. Because of the low available water capacity, little benefit is derived from fallowing. Also, fallowing increases the susceptibility to soil blowing.

Intermediate wheatgrass, pubescent wheatgrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard. The dense, sodic subsoil, which restricts root penetration, and the salts, which reduce the amount of water available to plants, are problems, especially if the pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the suitable plants helps to control soil blowing and prevent denuding.

This soil is suited to only a few of the most drought- and salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Supplemental watering helps to ensure the survival of seedlings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the restricted root development in the dense, sodic subsoil and the reduced available water capacity caused by the salts in the soil. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IVs. The productivity index for spring wheat is 29. The range site is Sandy Claypan. The pasture group is Claypan.

1182—Lohnes loamy sand, 0 to 6 percent slopes. This very deep, level to undulating, well drained soil is on flats and rises on outwash plains. Individual areas range from about 4 to more than 75 acres in size.

Typically, the surface soil is loamy sand about 14 inches thick. It is black in the upper part and very dark grayish brown in the lower part. The subsoil is dark brown loamy sand about 6 inches thick. The substratum to a depth of about 60 inches is dark brown, calcareous coarse sand. In some areas, the surface soil and subsoil are sandy loam and the substratum is gravelly sand.

Included with this soil in mapping are small areas of the excessively drained Claire soils. These soils make up about 10 percent of the unit. They are intermingled with areas of the Lohnes soil.

Permeability is rapid in the Lohnes soil. Runoff is slow. Available water capacity is very low. Organic matter content is moderately low. Tilth is fair.

Most areas are used for cultivated crops. Some are used for range, hay, or pasture. Because of droughtiness, this soil is very poorly suited to small grain, flax, and sunflowers. Rye or winter wheat makes the best use of the early season moisture supply and helps protect the surface against soil blowing in fall, winter, and spring. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. A system of conservation tillage that leaves crop residue on the

surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow and thus increasing the moisture supply. Because of the very low available water capacity, little benefit is derived from fallowing. Also, fallowing increases the susceptibility to soil blowing.

In areas where this soil is used for range, the important forage plants are prairie sandreed, needleandthread, and sand bluestem. Intermediate wheatgrass, pubescent wheatgrass, green needlegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and droughtiness are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants at a height that traps snow increases the moisture supply and helps to control soil blowing. Denuding can occur along cattle trails. It can be prevented by a planned grazing system that controls the pattern of livestock traffic.

This soil is suited to a few of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It is droughty, and the trees and shrubs commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Because of the very low available water capacity, little benefit is derived from fallowing the season prior to planting. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IVe. The productivity index for spring wheat is 36. The range site is Sands. The pasture group is Shallow to Gravel.

1206—Maddock loamy fine sand, 6 to 25 percent slopes. This very deep, gently rolling to hilly, well drained soil is on rises on wind-sculptured lake plains. Individual areas range from about 6 to more than 90 acres in size.

Typically, the surface layer is very dark gray loamy fine sand about 6 inches thick. The subsoil is very dark grayish brown loamy fine sand about 7 inches thick. The next layer is brown fine sand about 20 inches thick. The substratum to a depth of about 60 inches also is brown fine sand.

Included with this soil in mapping are some small areas of excessively drained soils that have a thin surface layer. These soils make up about 5 percent of the unit. They are on summits.

Permeability is rapid in the Maddock soil. Runoff is slow. Available water capacity is low. Organic matter content is moderately low.

Most areas are used for range, hay, or pasture. Because of droughtiness, the slope, and a severe hazard of soil blowing, this soil is generally unsuited to cultivated crops and to trees and shrubs. The important forage plants in areas of range are prairie sandreed, needleandthread, and sand bluestem. Intermediate wheatgrass, pubescent wheatgrass, sand bluestem, and alfalfa are suitable hay and pasture plants. Soil blowing and droughtiness are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants at a height that traps snow increases the moisture supply and helps to control soil blowing. Denuding can occur along cattle trails. It can be prevented by a planned grazing system that controls the pattern of livestock traffic.

The land capability classification is VIe. The productivity index for spring wheat is 0. The range site and pasture group are Sands.

1221—Maddock-Hecla loamy fine sands, 1 to 6 percent slopes. These very deep soils are on wind-sculptured lake plains. The nearly level and undulating, well drained Maddock soil is on rises. The nearly level, moderately well drained Hecla soil is on flats and in swales. Individual areas range from about 10 to more than 200 acres in size. They are about 60 to 80 percent Maddock soil and 10 to 25 percent Hecla soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Maddock soil has a surface layer of very dark gray loamy fine sand about 6 inches thick. The subsoil is very dark grayish brown loamy fine sand about 7 inches thick. The next layer is brown fine sand about 20 inches thick. The substratum to depth of about 60 inches also is brown fine sand.

Typically, the Hecla soil has a surface soil of black loamy fine sand about 20 inches thick. The next layer is very dark grayish brown loamy fine sand about 6 inches thick. The substratum to a depth of about 60 inches is mottled. It is brown fine sand in the upper part and grayish brown, calcareous loamy fine sand in the lower part.

Included with these soils in mapping are small areas of Embden, Hamar, and Letcher soils and small areas of soils that have a thin surface layer. These included soils make up about 10 percent of the unit. Embden soils have a surface soil and subsoil of fine sandy loam. They are intermingled with areas of the Hecla soil. Hamar soils are somewhat poorly drained. They are in

swales. Letcher soils have a sodic subsoil. They are intermingled with areas of the Hecla soil. The soils that have a thin surface layer are on knolls and ridges.

Permeability is rapid in the Maddock and Hecla soils. Runoff is slow. Available water capacity is low. Organic matter content is moderately low. A seasonal high water table is at a depth of 3 to 6 feet in the Hecla soil. Tilth is fair in both soils.

Most areas are used for cultivated crops, range, hay, or pasture. Because of droughtiness, these soils are poorly suited to small grain, flax, and sunflowers. Rye or winter wheat makes the best use of the early season moisture supply and helps to control soil blowing in fall, winter, and spring. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing (fig. 8). Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow and thus increasing the moisture supply. Because of the low available water capacity, little benefit is derived from fallowing. Also, fallowing increases the susceptibility to soil blowing.

In areas where these soils are used for range, the important forage plants are prairie sandreed, needleandthread, and sand bluestem. Intermediate wheatgrass, pubescent wheatgrass, sand bluestem, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants at a height that traps snow increases the moisture supply and helps to control soil blowing. Denuding can occur along cattle trails. It can be prevented by a planned grazing system that controls the pattern of livestock traffic.

The Maddock soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Hecla soil is suited to all of the climatically adapted species. The Maddock soil is somewhat droughty. The trees and shrubs on this soil commonly are affected by moisture stress, particularly during the establishment period. Supplemental watering helps to ensure the survival of seedlings. Because of the low available water capacity, little benefit is derived from fallowing the season prior to planting. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of both soils is IVe. The productivity index of the unit for spring wheat is 41. The range site and pasture group of both soils are Sands.

1269—Marysland silt loam. This very deep, level, poorly drained, highly calcareous soil is in swales and drainageways on outwash plains. Individual areas range from about 6 to more than 100 acres in size.

Typically, the surface layer is black, calcareous silt loam about 6 inches thick. The next layer is very dark gray, calcareous silt loam about 12 inches thick. The subsoil is mottled, calcareous loam about 14 inches thick. It is gray and light olive gray in the upper part and olive gray in the lower part. The substratum to a depth of about 60 inches is mottled and calcareous. In sequence downward, it is olive gray gravelly loamy coarse sand, olive brown coarse sand, dark grayish brown sand, and dark grayish brown gravelly coarse sand. In some areas the substratum is silt loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Divide soils on flats. These soils make up about 5 percent of the unit.

Permeability is moderate in the upper part of the Marysland soil and rapid in the lower part. Runoff is slow. Available water capacity is moderate. Organic matter content is high. A seasonal high water table is within a depth of 2 feet. The root zone is moderately deep because of the substratum of coarse sand. Tilth is good.

Most areas are used for range, hay, or pasture. If drained, this soil is suited to small grain, flax, and sunflowers. Suitable drainage outlets are not readily available. As a result, few areas are drained. In undrained areas wetness frequently delays or prevents tillage, seeding, and harvesting. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The main concerns in managing cultivated areas are controlling soil blowing and overcoming wetness. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. A surface drainage system improves the suitability for crops.

In areas where this soil is used for range, the important forage plants are big bluestem, switchgrass, prairie cordgrass, and northern reedgrass. Creeping foxtail, big bluestem, and alsike clover are suitable hay and pasture plants. Soil blowing is a hazard, especially

Figure 8.—An area of Maddock-Hecla loamy fine sands, 1 to 6 percent slopes. Stripcropping and field windbreaks help to control soil blowing.

if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. In undrained areas, however, it is generally unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIw. The productivity index for spring wheat ranges from 32 to 61, depending on the degree of drainage. The range site is Subirrigated. The pasture group is Wet.

1291—Metigoshe sandy loam, 3 to 9 percent slopes. This very deep, undulating and gently rolling, well drained soil is on rises and knobs on outwash plains. Individual areas range from about 8 to more than 70 acres in size.

Typically, the surface layer is black sandy loam about

5 inches thick. It is covered by a 1-inch layer of organic material. The subsurface layer is very dark grayish brown loamy sand about 3 inches thick. The subsoil is dark brown sandy loam about 7 inches thick. The substratum to a depth of about 60 inches is calcareous gravelly sand. It is dark brown in the upper part and dark grayish brown in the lower part.

Included with this soil in mapping are small areas of Kelvin and Rolla soils. These soils make up about 20 percent of the unit. They are intermingled with areas of the Metigoshe soil. Kelvin soils have a substratum of clay loam. Rolla soils have a substratum of silty clay.

Permeability is moderate in the upper part of the Metigoshe soil and very rapid in the lower part. Runoff is medium. Available water capacity is low. Organic matter content is moderate. The root zone is shallow because of the substratum of gravelly sand. Tilth is good.

Most areas are used for cultivated crops or hay. This soil is poorly suited to small grain and flax. Rye or winter wheat makes the best use of the early season moisture supply and helps to control soil blowing in fall, winter, and spring. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow and thus increasing the moisture supply. Because of the very low available water capacity, little benefit is derived from fallowing. Also, fallowing increases the susceptibility to soil blowing.

Crested wheatgrass, western wheatgrass, and green needlegrass are suitable hay and pasture plants. Soil blowing and droughtiness are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants at a height that traps snow increases the moisture supply and helps to control soil blowing. Denuding can occur along cattle trails. It can be prevented by a planned grazing system that controls the pattern of livestock traffic.

This soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The soil is droughty, and the trees and shrubs commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Because of the low available water capacity, little benefit is derived from fallowing the season prior to planting. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IVe. The productivity index for spring wheat is 48. No range site is assigned. The pasture group is Very Shallow to Gravel.

1292—Metigoshe sandy loam, 9 to 25 percent slopes. This very deep, rolling and hilly, well drained soil is on knolls on outwash plains. Individual areas range from about 8 to more than 100 acres in size.

Typically, the surface layer is black sandy loam about 5 inches thick. It is covered by a 1-inch layer of organic material. The subsurface layer is very dark grayish brown loamy sand about 3 inches thick. The subsoil is dark brown sandy loam about 7 inches thick. The substratum to a depth of about 60 inches is calcareous gravelly sand. It is dark brown in the upper part and dark grayish brown in the lower part.

Included with this soil in mapping are small areas of Kelvin soils. These soils make up about 15 percent of the unit. They have a substratum of clay loam. They are intermingled with areas of the Metigoshe soil.

Permeability is moderate in the upper part of the Metigoshe soil and very rapid in the lower part. Runoff is rapid. Available water capacity is low. Organic matter content is moderate. The root zone is shallow because of the substratum of gravelly sand.

Most of the acreage is native woodland used for pasture. Because of droughtiness, the slope, and a severe hazard of soil blowing, this soil is generally unsuited to cultivated crops and to trees and shrubs. Crested wheatgrass, western wheatgrass, and green needlegrass are suitable hay and pasture plants. Soil blowing and droughtiness are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants at a height that traps snow increases the moisture supply and helps to control soil blowing. Denuding can occur along cattle trails. It can be prevented by a planned grazing system that controls the pattern of livestock traffic.

The land capability classification is VIe. The productivity index for spring wheat is 0. No range site is assigned. The pasture group is Very Shallow to Gravel.

1300—Miranda-Cavour loams. These very deep, level, sodic soils are on till plains. The somewhat poorly drained, saline Miranda soil is on flats. The moderately well drained Cavour soil is on rises. Individual areas range from about 7 to more than 50 acres in size. They

are about 50 to 75 percent Miranda soil and 25 to 45 percent Cavour soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Miranda soil has a surface layer of very dark gray loam about 2 inches thick. The subsoil is about 43 inches thick. In sequence downward, it is very dark gray clay loam; very dark grayish brown clay loam; dark brown, calcareous loam; and dark yellowish brown, mottled, calcareous clay loam. The substratum to a depth of about 60 inches is dark yellowish brown, mottled, calcareous clay loam.

Typically, the Cavour soil has a surface layer of black loam about 5 inches thick. The subsurface layer is very dark grayish brown loam about 2 inches thick. The subsoil is about 32 inches thick. It is black clay loam in the upper part; brown, mottled, calcareous loam in the next part; and dark grayish brown, mottled, calcareous loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

Included with these soils in mapping are small areas of the saline Hamerly soils. These included soils make up about 5 percent of the unit. They do not have a sodic subsoil. They are intermingled with areas of the Miranda soil.

Permeability is very slow in the Miranda and Cavour soils. Runoff is slow. Available water capacity is low in the Miranda soil and moderately low in the Cavour soil. The salts in both soils reduce the amount of water available to plants. Organic matter content is moderately low in the Miranda soil and moderate in the Cavour soil. A seasonal high water table is at a depth of 2 to 4 feet in the Miranda soil and at a depth of 4 to 6 feet in the Cavour soil. The root zone is very shallow in the Miranda soil and shallow in the Cavour soil because of the dense, sodic subsoil. Tilth is poor in both soils.

Most areas are used for cultivated crops. Because of the dense, sodic subsoil and the salts, these soils are generally unsuited to small grain, flax, and sunflowers. They are best suited to range, hay, and pasture. Converting cultivated areas to range or pasture helps to control erosion.

In areas where these soils are used for range, the important forage species are western wheatgrass, blue grama, and needleandthread. Intermediate wheatgrass, western wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. The dense, sodic subsoil, which restricts the penetration of roots, and the salts, which reduce the amount of water available to plants, are problems, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to prevent denuding. Stock water ponds constructed in areas of these soils frequently contain salty water.

The Miranda soil is generally unsuited to the trees and shrubs grown as windbreaks and environmental plantings. The Cavour soil is suited to only a few of the drought- and salt-tolerant species. Supplemental watering helps to ensure the survival of seedlings. Individual trees and shrubs growing on the Cavour soil vary in height, density, and vigor, which are affected by the restricted root development in the dense, sodic subsoil and the reduced available water capacity caused by the salts in the soil.

The land capability classification of the Miranda soil is VIs, and that of the Cavour soil is IVs. The productivity index of the unit for spring wheat is 0. The range site and pasture group of the Miranda soil are Thin Claypan, and those of the Cavour soil are Claypan.

1426—Parnell silt loam. This very deep, level, very poorly drained soil is in moderately deep depressions on till plains. It is subject to ponding. Individual areas range from about 4 to more than 20 acres in size.

Typically, the surface soil is black silt loam about 11 inches thick. The subsoil is silty clay loam about 26 inches thick. It is black in the upper part and dark olive gray and mottled in the lower part. The substratum to a depth of about 60 inches is olive gray and mottled. It is loam in the upper part and calcareous clay loam in the lower part.

Included with this soil in mapping are small areas of Southam and Vallers soils. These soils make up about 15 percent of the unit. Southam soils do not have an accumulation of clay in the subsoil. They are in the deepest parts of the depressions. Vallers soils are poorly drained. They are on the rim of the depressions.

Permeability is slow in the Parnell soil. Runoff is ponded. Available water capacity and organic matter content are high. A seasonal high water table is 2 feet above to 2 feet below the surface. Tilth is good.

Most areas are used for range, hay, pasture, or wetland wildlife habitat. If drained, this soil is suited to small grain, flax, and sunflowers. Suitable drainage outlets are not readily available. As a result, few areas are drained. In undrained areas, ponding prevents or delays tillage, seeding, and harvesting and crops are harvested in only about 1 or 2 years out of 10. The hazards of soil blowing and water erosion are slight. A system of conservation tillage that leaves crop residue on the surface helps to control localized erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used for range, the important forage plants are rivergrass, prairie cordgrass,

northern reedgrass, and slough sedge. Reed canarygrass and creeping foxtail are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed during wet periods. Grazing should be deferred when the soil is wet.

The soil and the ponded water provide feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. In undrained areas, however, it is generally unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of seedlings.

The land capability classification is IIIw. The productivity index for spring wheat ranges from 19 to 66, depending on the degree of drainage. The range site is Wetland. In drained areas the pasture group is Wet.

1466—Pits, sand and gravel. This unit consists of areas from which soil material has been removed and the underlying sand and gravel have been mined. The mining activity has resulted in irregularly shaped pits and fill areas. Individual areas range from about 4 to more than 50 acres in size. Most areas are barren of vegetation.

This unit is generally unsuited to cultivated crops, hay, pasture, and trees.

The land capability classification is VIIIs. The productivity index for spring wheat is 0. No range site or pasture group is assigned.

1523—Renshaw loam, 0 to 3 percent slopes. This very deep, level and nearly level, somewhat excessively drained soil is on flats on outwash plains. Individual areas range from about 20 to more than 200 acres in size.

Typically, the surface layer is black loam about 6 inches thick. The subsoil is loam about 10 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The substratum to a depth of about 60 inches is calcareous gravelly coarse sand. It is dark grayish brown in the upper part and dark brown in the lower part. In some areas the dark color of the surface layer extends to a depth of more than 16 inches.

Included with this soil in mapping are small areas of Arvilla, Divide, and Sioux soils. These soils make up about 25 percent of the unit. Arvilla soils are sandy loam in the surface layer and in the upper part of the subsoil. They are intermingled with areas of the Renshaw soil. Divide soils are somewhat poorly drained. They are in swales. Sioux soils have sand and gravel within a depth of 14 inches. They are intermingled with areas of the Renshaw soil.

Permeability is moderate in the upper part of the Renshaw soil and very rapid in the lower part. Runoff is slow. Available water capacity is low. Organic matter content is moderate. The root zone is shallow because of the substratum of gravelly coarse sand. Tilth is good.

Most areas are used for cultivated crops. Because of droughtiness, this soil is very poorly suited to small grain, flax, and sunflowers. Rye or winter wheat makes the best use of the early season moisture supply and helps to control soil blowing in fall, winter, and spring. The hazards of soil blowing and water erosion are slight. The main concern in managing cultivated areas is overcoming the droughtiness. Localized erosion can easily be controlled by a system of conservation tillage that leaves crop residue on the surface. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow and thus increasing the moisture supply. Because of the low available water capacity, little benefit is derived from fallowing. Also, fallowing increases the susceptibility to soil blowing.

Intermediate wheatgrass, pubescent wheatgrass, green needlegrass, and alfalfa are suitable hay and pasture plants. Droughtiness is a problem, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants at a height that traps snow increases the moisture supply and helps to control localized erosion.

This soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It is droughty, and the trees and shrubs commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Because of the low available water capacity, little benefit is derived from fallowing the season prior to planting. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIIs. The

productivity index for spring wheat is 43. The range site and pasture group are Shallow to Gravel.

1571—Rolla silty clay, 0 to 6 percent slopes. This very deep, level to gently sloping, moderately well drained soil is on flats and rises on lake plains. Individual areas range from about 10 to more than 1,000 acres in size.

Typically, the surface layer is dark gray silty clay about 6 inches thick. It is covered by a 2-inch layer of organic material. The subsoil is about 24 inches thick. It is dark grayish brown clay in the upper part, dark grayish brown and dark brown clay in the next part, and dark brown, calcareous silty clay in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, calcareous silty clay.

Included with this soil in mapping are small areas of the very poorly drained Eramosh soils in depressions. These soils make up about 5 percent of the unit.

Permeability is slow in the Rolla soil. Runoff is medium. Available water capacity and organic matter content are high. Tilth is poor.

Most areas are used for cultivated crops. This soil is well suited to small grain, flax, hay, and pasture. The hazards of soil blowing and water erosion are moderate. The main concerns in managing cultivated areas are controlling soil blowing and water erosion and improving tilth. A system of conservation tillage that leaves crop residue on the surface, stripcropping, grassed waterways in areas where runoff concentrates, and field windbreaks help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. The soil can be easily tilled only within a narrow range in moisture content because it is very sticky and tends to puddle when wet and is very hard and tends to be cloddy when dry. Fall tillage and periods of freezing and thawing and of wetting and drying throughout winter improve tilth in the surface layer and thus facilitate seedbed preparation. Fall tillage, however, increases the susceptibility to soil blowing.

Western wheatgrass, Russian wildrye, smooth bromegrass, and alfalfa are suitable hay and pasture plants (fig. 9). Soil blowing and water erosion are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control erosion.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIe. The productivity index for spring wheat is 71. No range site is assigned. The pasture group is Clayey.

1572—Rolla silty clay, 6 to 15 percent slopes. This very deep, moderately sloping and strongly sloping, moderately well drained soil is on side slopes on collapsed lake plains. Individual areas range from about 10 to more than 100 acres in size.

Typically, the surface layer is dark gray silty clay about 6 inches thick. It is covered by a 2-inch layer of organic material. The subsoil is about 24 inches thick. It is dark grayish brown clay in the upper part, dark grayish brown and dark brown clay in the next part, and dark brown, calcareous silty clay in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, calcareous silty clay.

Included with this soil in mapping are small areas of the very poorly drained Eramosh soils in depressions. These soils make up about 5 percent of the unit.

Permeability is slow in the Rolla soil. Runoff is rapid. Available water capacity and organic matter content are high. Tilth is poor.

Most areas are used for cultivated crops. This soil is poorly suited to small grain and flax. The hazard of soil blowing is moderate, and the hazard of water erosion is severe. The main concerns in managing cultivated areas are controlling soil blowing and water erosion and improving tilth. A system of conservation tillage that leaves crop residue on the surface, stripcropping, grassed waterways in areas where runoff concentrates, and field windbreaks help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. The soil can be easily tilled only within a narrow range in moisture content because it is very sticky and tends to puddle when wet and is very hard and tends to be cloddy when dry. Fall tillage and periods of freezing and thawing and of wetting and drying throughout winter improve tilth in the surface layer and thus facilitate seedbed preparation. Fall tillage, however, increases the susceptibility to soil blowing and water erosion.

Western wheatgrass, Russian wildrye, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and

Figure 9.—Hay in an area of Rolla silty clay, 0 to 6 percent slopes. Rolla silty clay, 6 to 15 percent slopes, is in the background.

environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IVe. The productivity index for spring wheat is 52. No range site is assigned. The pasture group is Clayey.

1687—Sioux loam, 0 to 6 percent slopes. This very deep, level to undulating, excessively drained soil is on flats and rises on outwash plains. Individual areas range from about 6 to more than 200 acres in size.

Typically, the surface layer is black loam about 5 inches thick. The next layer is very dark grayish brown gravelly sandy loam about 4 inches thick. The substratum to a depth of about 60 inches is dark brown and calcareous. It is very gravelly coarse sand in the upper part and gravelly coarse sand in the lower part. In some areas the soil is stony or very stony.

Included with this soil in mapping are small areas of Arvilla and Renshaw soils. These soils make up about 25 percent of the unit. They are intermingled with areas

of the Sioux soil. They have sand and gravel at a depth of 14 to 20 inches.

Permeability is very rapid in the Sioux soil. Runoff is slow. Available water capacity is low. Organic matter content is moderately low. The root zone is very shallow because of the substratum of very gravelly or gravelly coarse sand.

Most areas are used for range or pasture. Because of droughtiness, this soil is generally unsuited to cultivated crops and to trees and shrubs. The important forage plants in areas of range are needleandthread, western wheatgrass, and blue grama. Crested wheatgrass, green needlegrass, and western wheatgrass are suitable hay and pasture plants. Droughtiness is a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants at a height that traps snow increases the moisture supply and helps to control localized erosion.

The land capability classification is VIs. The productivity index for spring wheat is 0. The range site is Very Shallow. The pasture group is Very Shallow to Gravel.

1691—Sioux loam, 6 to 25 percent slopes. This very deep, gently rolling to hilly, excessively drained soil is on rises and ridges on outwash plains. Individual areas range from about 7 to more than 75 acres in size.

Typically, the surface layer is black loam about 5 inches thick. The next layer is very dark grayish brown gravelly sandy loam about 4 inches thick. The substratum to a depth of about 60 inches is dark brown and calcareous. It is very gravelly coarse sand in the upper part and gravelly coarse sand in the lower part.

Included with this soil in mapping are small areas of Arvilla and Lohnes soils. These soils make up about 20 percent of the unit. They are intermingled with areas of the Sioux soil. Arvilla soils have sand and gravel at a depth of 14 to 20 inches. Lohnes soils have a surface layer of loamy sand.

Permeability is very rapid in the Sioux soil. Runoff is slow. Available water capacity is low. Organic matter content is moderately low. The root zone is very shallow because of the substratum of very gravelly or gravelly coarse sand.

Most areas are used for range or pasture. Because of droughtiness, this soil is generally unsuited to cultivated crops and to trees and shrubs. The important forage plants in areas of range are needleandthread, western wheatgrass, and blue grama. Crested wheatgrass, green needlegrass, and western wheatgrass are suitable hay and pasture plants. Droughtiness is a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants at a height that traps snow increases the moisture supply and helps to control localized erosion. Denuding can occur along cattle trails. It can be prevented by a planned grazing system that controls the pattern of livestock traffic.

The land capability classification is VIs. The productivity index for spring wheat is 0. The range site is Very Shallow. The pasture group is Very Shallow to Gravel.

1709—Southam silt loam. This very deep, level, very poorly drained soil is in deep depressions on till plains and lake plains. It is subject to ponding. Individual areas range from about 4 to more than 80 acres in size.

Typically, a 3-inch cover of undecomposed stems, leaves, and roots is at the surface. The surface soil is about 26 inches thick. It is black and calcareous. It is silt loam in the upper part and silty clay loam in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous clay loam.

Included with this soil in mapping are small areas of water. These areas make up about 10 percent of the unit.

Permeability is slow in the Southam soil. Runoff is ponded. Available water capacity and organic matter content are high. A seasonal high water table is 5 feet above to 1 foot below the surface.

Most areas of this soil are used for wetland wildlife habitat. The soil is best suited to this use. Because of the ponding, it is generally unsuited to cultivated crops, hay, pasture, and trees and shrubs. Suitable drainage outlets are not readily available. As a result, few areas are drained. The soil and the ponded water provide excellent winter cover for resident wildlife and high-quality feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

The land capability classification is VIIIw. The productivity index for spring wheat is 0. No range site or pasture group is assigned.

1727—Stirum fine sandy loam. This very deep, level, poorly drained, sodic, moderately saline soil is in swales on lake plains and outwash plains. Individual areas range from about 4 to more than 100 acres in size.

Typically, the surface layer is black fine sandy loam about 5 inches thick. The subsurface layer is very dark grayish brown fine sand about 2 inches thick. The subsoil is about 28 inches thick. It is mottled and calcareous. It is gray fine sandy loam in the upper part, olive gray loamy fine sand in the next part, and olive

gray fine sandy loam in the lower part. The substratum to a depth of about 60 inches is mottled and calcareous. It is olive gray loamy fine sand in the upper part, dark gray silt loam in the next part, and gray very fine sandy loam in the lower part.

Included with this soil in mapping are small areas of Letcher and Ulen soils. These soils make up about 10 percent of the unit. Letcher soils are moderately well drained. They are on rises. Ulen soils do not have a sodic subsoil. They are on flats.

Permeability is moderately slow in the upper part of the Stirum soil and moderately rapid in the lower part. Runoff is very slow. Available water capacity is low. The salts in the soil reduce the amount of water available to plants. Organic matter content is moderate. A seasonal high water table is at a depth of 1 to 3 feet. The root zone is very shallow because of the dense, sodic subsoil.

Most areas are used for range, hay, or pasture. Because of the dense, sodic subsoil, this soil is generally unsuited to cultivated crops. The important forage plants in areas of range are big bluestem, switchgrass, prairie cordgrass, and northern reedgrass. Tall wheatgrass, western wheatgrass, alkali sacaton, and sweetclover are suitable hay and pasture plants. Soil blowing is a problem, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil is suited to only a few of the drought- and salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Supplemental watering helps to ensure the survival of seedlings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the restricted root development in the dense, sodic subsoil and the reduced available water capacity caused by the salts in the soil. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is VIs. The productivity index for spring wheat is 0. The range site is Subirrigated. The pasture group is Sodic and Saline.

1780—Swenoda fine sandy loam. This very deep, level, moderately well drained soil is on flats on till plains and lake plains. Individual areas range from about 5 to more than 100 acres in size.

Typically, the surface soil is black fine sandy loam about 12 inches thick. The subsoil is about 26 inches thick. It is very dark grayish brown fine sandy loam in the upper part, dark brown fine sandy loam in the next part, and light olive brown, mottled, calcareous loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In some places the substratum is fine sandy loam. In other places the dark color of the surface layer extends to a depth of only 8 to 16 inches.

Included with this soil in mapping are small areas of Towner and Wyndmere soils. These soils make up about 10 percent of the unit. Towner soils have a surface soil and subsoil of loamy fine sand. They are intermingled with areas of the Swenoda soil. Wyndmere soils are somewhat poorly drained. They are on flats and in swales.

Permeability is moderately rapid in the upper part of the Swenoda soil and moderately slow in the lower part. Runoff is slow. Available water capacity and organic matter content are high. A seasonal high water table is at a depth of 2.5 to 4.0 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to small grain, flax, and sunflowers. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main concern in managing cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

Intermediate wheatgrass, pubescent wheatgrass, switchgrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index for spring wheat is 78. The range site and pasture group are Sandy.

1843—Towner loamy fine sand, 0 to 6 percent slopes. This very deep, level to undulating, moderately well drained soil is on flats and rises on wind-sculptured till plains and lake plains. Individual areas range from about 10 to more than 100 acres in size.

Typically, the surface soil is very dark gray loamy fine sand about 10 inches thick. The subsoil is loamy fine sand about 21 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower

part. The substratum to a depth of about 60 inches is brown, calcareous loam. In some places the dark color of the surface layer extends to a depth of only 8 to 16 inches. In other places the substratum is loamy fine sand or sand.

Included with this soil in mapping are small areas of Swenoda and Ulen soils. These soils make up about 10 percent of the unit. Swenoda soils are fine sandy loam in the surface soil and in the upper part of the subsoil. They are intermingled with areas of the Towner soil. Ulen soils are somewhat poorly drained. They are on flats.

Permeability is rapid in the upper part of the Towner soil and moderately slow in the lower part. Runoff is slow. Available water capacity is moderate. Organic matter content is moderately low. A seasonal high water table is at a depth of 3 to 6 feet. Tilth is fair.

Most areas are used for cultivated crops or hay. Some areas are used for pasture. Because of droughtiness, this soil is poorly suited to small grain, flax, and sunflowers. Rye or winter wheat makes the best use of the early season moisture supply and helps to control soil blowing in fall, winter, and spring. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow and thus increasing the moisture supply. Because of the moderate available water capacity, little benefit is derived from fallowing. Also, fallowing increases the susceptibility to soil blowing.

Intermediate wheatgrass, pubescent wheatgrass, sand bluestem, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants at a height that traps snow increases the moisture supply and helps to control soil blowing. Denuding can occur along cattle trails. It can be prevented by a planned grazing system that controls the pattern of livestock traffic.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It is somewhat droughty, and the trees and shrubs commonly are affected by moisture stress, particularly during the establishment period. Supplemental watering helps to ensure the survival of seedlings. Because of the moderate available water capacity, little benefit is derived from fallowing the season prior to planting. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IVe. The productivity index for spring wheat is 50. The range site and pasture group are Sands.

1859—Ulen fine sandy loam. This very deep, level, somewhat poorly drained, highly calcareous soil is on flats and in swales on wind-sculptured lake plains. Individual areas range from about 4 to more than 100 acres in size.

Typically, the surface layer is black, calcareous fine sandy loam about 8 inches thick. The subsoil is dark gray, calcareous loamy fine sand about 6 inches thick. The next layer is grayish brown, mottled, calcareous fine sand about 6 inches thick. The substratum to a depth of about 60 inches is olive, mottled, calcareous sand. In some areas the soil has a layer of lime accumulation below a depth of 16 inches.

Included with this soil in mapping are small areas of Hecla and Stirum soils. These soils make up about 15 percent of the unit. Hecla soils are moderately well drained. They are intermingled with areas of the Ulen soil. Stirum soils are poorly drained. They are in swales.

Permeability is rapid in the Ulen soil. Runoff is slow. Available water capacity is low. Organic matter content is moderate. A seasonal high water table is at a depth of 2.5 to 6.0 feet. Tilth is good.

Most areas are used for cultivated crops, range, hay, or pasture. Because of droughtiness, this soil is poorly suited to small grain, flax, and sunflowers. Rye or winter wheat makes the best use of the early season moisture supply and helps to control soil blowing in fall, winter, and spring. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main concern in managing cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used for range, the important forage plants are little bluestem, big bluestem, indiangrass, and switchgrass. Tall wheatgrass, big bluestem, little bluestem, and birdsfoot trefoil are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or

suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index for spring wheat is 55. The range site and pasture group are Limy Subirrigated.

1871—Vallers loam, saline. This very deep, level, poorly drained, highly calcareous, moderately saline soil is on flats on till plains. Individual areas range from about 6 to more than 40 acres in size.

Typically, the surface layer is black, calcareous loam about 8 inches thick. It has an accumulation of salts. The subsoil is mottled, calcareous loam about 22 inches thick. It is light brownish gray in the upper part and grayish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled, calcareous loam. In some places the subsoil is olive brown or dark brown. In other places the soil is nonsaline.

Included with this soil in mapping are small areas of Hamerly and Parnell soils. These soils make up about 15 percent of the unit. Hamerly soils are somewhat poorly drained. They are intermingled with areas of the Vallers soil. Parnell soils are very poorly drained. They are in depressions.

Permeability is moderately slow in the Vallers soil. Runoff is slow. Available water capacity is moderate. The salts in the soil reduce the amount of water available to plants. Organic matter content is high. A seasonal high water table is within a depth of 1 foot. Tilth is good.

Most areas are used for range, hay, or pasture. Some are used for cultivated crops. If drained, this soil is poorly suited to small grain, flax, and sunflowers because of salinity. Suitable drainage outlets are not readily available. As a result, few areas are drained. In undrained areas wetness frequently delays or prevents tillage, seeding, and harvesting. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The main concerns in managing cultivated areas are controlling soil blowing and overcoming salinity. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. A permanent cover of crops helps to control the accumulation of salts in the surface layer by reducing the evaporation rate at the surface.

In areas where this soil is used for range, the important forage species are Nuttall alkaligrass, inland saltgrass, alkali cordgrass, and western wheatgrass. Tall wheatgrass, alkali sacaton, and sweetclover are suitable hay and pasture plants. Soil blowing is a hazard. The high content of salts and the reduced available water capacity are problems, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable salt-tolerant plants helps to control soil blowing. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil is suited to only a few of the most salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the reduced available water capacity caused by the salts in the soil. Reducing the evaporation rate at the surface improves seedling survival. If the surface is bare as the soil becomes dry, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIs. The productivity index for spring wheat is 22. The range site is Saline Lowland. The pasture group is Saline.

1978—Water. This unit occurs as areas of water that are about 5 to more than 50 feet deep. Individual areas range from about 5 to more than 1,000 acres in size. The smaller areas generally are shallow ponds and streams, and the larger areas generally are deep lakes and streams. Most areas are irregularly shaped, circular, or oblong, but the streams generally are long and narrow.

Included in this unit in mapping are small areas of Colvin and Southam soils. These soils make up about 5 percent of the unit. They are in oxbows or on the perimeter of the mapped areas. Colvin soils are poorly drained. Southam soils are very poorly drained.

Most areas are used for wildlife habitat and recreation. They are best suited to these uses. Most areas serve as a good source of water for livestock, but some areas are poorly suited to this use because the water is brackish.

2046—Wyndmere fine sandy loam. This very deep, level, somewhat poorly drained, highly calcareous soil is on flats and in swales on lake plains. Individual areas range from about 5 to more than 50 acres in size.

Typically, the surface layer is black, calcareous fine

sandy loam about 7 inches thick. The subsoil is calcareous fine sandy loam about 22 inches thick. It is dark grayish brown in the upper part, dark brown in the next part, and grayish brown in the lower part. The substratum to a depth of about 60 inches is olive, mottled, calcareous loamy fine sand. In some areas the soil has a layer of lime accumulation below a depth of 16 inches.

Included with this soil in mapping are small areas of Embden and Ulen soils. These soils make up about 15 percent of the unit. Embden soils are moderately well drained. They are on flats. Ulen soils have a subsoil of loamy fine sand and a substratum of sand. They are intermingled with areas of the Wyndmere soil.

Permeability is moderately rapid in the Wyndmere soil. Runoff is slow. Available water capacity is moderate. Organic matter content is high. A seasonal high water table is at a depth of 2 to 5 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain, flax, and sunflowers. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main concern in managing cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

Tall wheatgrass, big bluestem, little bluestem, and birdsfoot trefoil are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index for spring wheat is 69. The range site and pasture group are Limy Subirrigated.

2059—Wyrene sandy loam. This very deep, level, somewhat poorly drained, highly calcareous soil is on flats and in swales on outwash plains. Individual areas range from about 4 to more than 75 acres in size.

Typically, the surface layer is black sandy loam about 8 inches thick. It is calcareous between depths of 5 and 8 inches. The subsoil is calcareous sandy loam about 16 inches thick. It is dark gray in the upper part and grayish brown and mottled in the lower part. The substratum to a depth of about 60 inches is calcareous. It is brown, mottled gravelly coarse sand in the upper part; olive brown coarse sand in the next part; and dark grayish brown gravelly coarse sand in the lower part. In some places the surface layer and subsoil are loam. In other places the soil has a layer of lime accumulation below a depth of 16 inches.

Included with this soil in mapping are small areas of the somewhat excessively drained Arvilla soils on rises. These soils make up about 10 percent of the unit.

Permeability is moderately rapid in the Wyrene soil. Runoff is slow. Available water capacity is low. Organic matter content is high. A seasonal high water table is at a depth of 3 to 5 feet. The root zone is moderately deep because of the substratum of gravelly coarse sand and coarse sand. Tilth is good.

Most areas are used for cultivated crops. Some are used for hay or pasture. Because of droughtiness, this soil is poorly suited to small grain, flax, and sunflowers. Rye or winter wheat makes the best use of the early season moisture supply and helps to control soil blowing in fall, winter, and spring. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. A system of conservation tillage that leaves crop residue on the surface, stripcropping, flax strips and other annual buffer strips, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow and thus increasing the moisture supply.

Tall wheatgrass, big bluestem, little bluestem, and birdsfoot trefoil are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index for spring wheat is 50. The range site and pasture group are Limy Subirrigated.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban or built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal expenditure of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service.

About 212,000 acres in the survey area, or more than 35 percent of the total acreage, meets the soil requirements for prime farmland.

The map units in the survey area that are considered prime farmland are listed in this section. 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 at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify as prime farmland only in areas where this limitation has been overcome by drainage measures. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

The map units that meet the requirements for prime farmland are:

64	Arveson loam (where drained)
118	Barnes-Buse loams, 3 to 6 percent slopes
137	Barnes-Hamerly loams, 0 to 3 percent slopes
167	Bearden silt loam
450	Colvin silt loam (where drained)
510	Divide loam
532	Eckman silt loam, 1 to 6 percent slopes
548	Egeland fine sandy loam, 0 to 6 percent slopes
569	Embden fine sandy loam
768	Gardena silt loam
800	Glyndon silt loam
846	Great Bend-Overly silt loams, 0 to 3 percent slopes
863	Hamerly loam, 0 to 3 percent slopes
987	Heimdal-Emrick loams, 0 to 3 percent slopes
992	Heimdal-Emrick-Esmond loams, 3 to 6 percent slopes
1104	Lanona-Swenoda fine sandy loams, 1 to 6 percent slopes
1269	Marysland silt loam (where drained)
1571	Rolla silty clay, 0 to 6 percent slopes
1780	Swenoda fine sandy loam
2046	Wyndmere fine sandy loam

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 to prevent 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 behavioral 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 rangeland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreational facilities; and for wildlife habitat. It can be used to identify the limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in 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

Prepared by Douglas A. Gasseling, agronomist, and Paulette M. Gustafson, district conservationist, Natural Resources Conservation Service.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Natural Resources Conservation Service is explained; and the estimated yields of the main crops 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 the heading "Detailed Soil Map Units." Specific information can be obtained from the local office of the Natural Resources Conservation Service or the North Dakota Cooperative Extension Service.

About 65 percent of Rolette County is cultivated. In 1990, about 209,700 acres was used for close-grown crops, 11,000 acres for row crops, and 51,000 acres for forage crops *(16)*. During the period 1985 to 1989, the acreage used for close-grown crops averaged 197,100 acres per year. The acreage of summer fallow was about 100,000 acres in 1988; 50,000 acres in 1989; and 40,000 acres in 1990 *(15)*. The acreage used for sunflowers is decreasing. It averaged 17,000 acres per year from 1985 to 1989. It was 12,600 acres in 1988 and 10,500 acres in 1989. The acreage used for corn and forage has been stable in recent years. In 1990, the acreages of the principal close-grown crops were as follows—spring wheat, 23,000 acres; durum wheat, 120,000 acres; barley, 51,000 acres; oats, 11,000 acres; rye, 400 acres; and flax, 4,300 acres. The main row crops were sunflowers and corn. Sunflowers were grown on 9,000 acres and corn on 2,000 acres. Alfalfa was grown on 25,000 acres and other hay crops on 36,000 acres. Small acreages were planted to mustard, buckwheat, sorghum, millet, and safflower. In 1990, approximately 57,600 acres was enrolled in the Conservation Reserve Program.

The potential of the soils in Rolette County for increased production of food and fiber is good. This production is steadily increasing as the latest crop production technology is applied. This soil survey can facilitate the application of this technology.

The soils and climate of Rolette County are suited to most of the crops that are commonly grown in the

county. The crops that are not commonly grown but are suitable include lentils, potatoes, and rapeseed.

The principal management measures that help to ensure continuing productivity are those that control soil blowing and water erosion, maintain or improve fertility and tilth, and result in proper utilization of soil moisture.

Soil blowing and water erosion reduce the productivity of the soils. If the surface layer is lost, most of the available plant nutrients also are lost. As a result, applications of fertilizer are needed to maintain adequate crop production.

Of equal concern is the loss of organic matter through erosion. Soil structure, water infiltration, available water capacity, and tilth are all negatively affected by this loss. As organic matter is lost and the subsoil is exposed and tilled, the remaining soil becomes increasingly susceptible to both soil blowing and water erosion.

Soil blowing is a hazard on some of the soils in Rolette County. It is a severe hazard on the coarse textured and moderately coarse textured soils, including Arvilla, Claire, Dickey, Egeland, Embden, Hamar, Hecla, Lanona, Letcher, Lohnes, Maddock, Metigoshe, Stirum, Swenoda, Towner, Ulen, Wyndmere, and Wyrene soils.

Bearden, Buse, Colvin, Divide, Esmond, Glyndon, Hamerly, Marysland, and Vallers soils have a relatively high content of lime and are susceptible to soil blowing in the spring if they have been bare throughout the winter. Because of freezing and thawing, soil structure breaks down, resulting in aggregates that are susceptible to movement. Nearly all soils can be damaged by soil blowing if they are bare.

Water erosion is a severe hazard on moderately sloping and steeper soils, such as Barnes, Buse, Esmond, Heimdal, Kelvin, and Rolla soils. It also is a severe hazard on the more gently sloping soils having long slopes. The hazard is greatest when the surface is bare.

Conservation practices that control both soil blowing and water erosion are those that maintain a protective cover. Examples are conservation tillage systems that keep a protective amount of crop residue on the surface. Applications of herbicides can help to eliminate the need for summer fallow tillage. Cover crops also are effective in controlling both soil blowing and water erosion. Field windbreaks, annual wind barriers, and stripcropping help to control soil blowing. Inclusion of grasses and legumes in the cropping sequence, grassed waterways, diversions, terraces, contour farming, and field stripcropping across the slope help to control water erosion. A management system that includes several measures is the best means of protecting the soil. For example, conservation tillage can control soil blowing during years when the amount of crop residue is adequate, but windbreaks are needed during years when the amount of residue is low.

Moisture at planting time is critical to the success of the crop during the growing season. In years when the amount of available soil moisture is low at planting time, the success of cropping is greatly reduced. Measures that reduce evaporation and runoff rates, increase the rate of water infiltration, and control weeds conserve moisture. Examples are crop residue management; a system of conservation tillage, such as no-till farming; stripcropping; cover crops; standing stubble and annual wind barriers, which trap snow; and applications of fertilizer.

Measures that improve fertility are needed on many soils. Examples are applications of commercial fertilizer, green manure crops, inclusion of legumes in the cropping sequence, and applications of barnyard manure.

Proper management of soils includes measures that maintain good tilth. These measures are especially needed on the soils that have a surface layer of silty clay loam, clay loam, or silty clay. Rolla soils are an example. Measures that maintain the content of organic matter are very important if good tilth is to be maintained. The traditional practice of clean-tilled summer fallow contributes to the loss of organic matter because it increases the susceptibility to erosion.

Management of Saline and Sodic Soils

Saline and sodic soils make up about 10 percent of Rolette County. Saline soils make up about 2 percent of the county, or 12,000 acres; sodic soils make up about 5 percent, or 27,000 acres; and saline-sodic soils make up about 3 percent, or 19,000 acres.

Saline soils have a high concentration of soluble salts, or salts that dissolve in water. The saline soils in Rolette County are phases of the Bearden, Colvin, Hamerly, and Vallers series.

Saline soils generally develop in areas of restricted drainage adjacent to natural sloughs and waterways. Where drainage is poor, salts rise with the water table and are concentrated near the surface. This salt buildup is reduced by plants and a surface cover. The plant roots use the soil water before it can reach the surface and before the salts accumulate. The surface cover prevents evaporation at the surface, the upward movement of water in the soil, and the concentration of salts at the surface.

Plants growing on saline soils absorb salts from the water in the soils. Excess amounts of certain salts may interfere with plant growth. High concentrations of some salts are toxic to certain plants. Some salts cause nutritional imbalances or deficiencies by restricting the uptake or availability of certain plant nutrients. Detecting

salinity by visual observations in the field is difficult. The salts generally are not visible during much of the growing season, particularly when the soil is moist. Flecks, threads, or masses of soluble salts are usually visible when the soil is dry. Laboratory analysis is needed to determine the actual degree of salinity in soils.

Crop response, particularly during periods of soil moisture stress, is a useful indicator of the degree of salinity in saline soils. For instance, a small grain crop growing on saline soils tends to be stunted and has fewer tillers than small grain on nonsaline soils. Strongly saline soils are best suited to native grasses or to salt-tolerant introduced grasses. Slightly saline or moderately saline soils can be used for salt-tolerant crops and forage. Barley is the most salt tolerant of the small grains. Of the forage crops, tall wheatgrass, western wheatgrass, and alfalfa are salt tolerant once they are established.

Sodic soils are characterized by a high content of exchangeable sodium, which adheres to the clay particles in the soils. The sodic soils in Rolette County are those of Aberdeen, Cathay, Cavour, Cresbard, Larson, Letcher, and Nahon series. Locally, sodic soils are known as "black-alkali," "slick spots," "pan spots," or "gumbo."

Sodic soils develop in a complex pattern with a very distinct microrelief. The physical and chemical properties of these soils differ markedly within very short distances. In many areas the distance between the sodic soils and the surrounding soils that have normal physical properties is only a few feet, perhaps 5 to 10 feet.

Sodic soils develop in areas of saline soils that contain large quantities of sodium salts. Over a long period, usually centuries, rainwater gradually leaches the salts from the surface to the lower horizons as the water table lowers. During this leaching process, the clay in the soils becomes saturated with sodium, disperses, and moves downward with the percolating water. As the moving clay concentrates, a dense, sodic subsoil forms. The dense subsoil is hard when dry, sticky when wet, and nearly impervious to roots, water, and air. Cavour, Larson, and Letcher are examples of soils that have a dense, sodic subsoil.

As leaching by water continues, the sodium is gradually moved lower in the profile and eventually is carried below the rooting depth. The result is a more manageable soil, such as Aberdeen, Cathay, and Cresbard soils. If the leaching process continues and nearly all of the sodium is removed from the profile, the soil eventually changes into a nonsodic soil. This change requires a long period, usually centuries *(5)*.

If plowed, sodic soils are characterized by a surface layer that is sticky when wet and hard and cloddy when dry. A crust forms easily at the surface. The chemical and physical properties of these soils do not favor plant growth. The harmful effects of the properties on plants generally increase as the sodium content increases. The effects of the reduced amount of water available to plants are more harmful than the toxic effect of the sodium. The plants also are affected by depth to the dense subsoil.

Identification of sodic soils in cultivated fields commonly is difficult because many of the physical characteristics, such as columnar structure, have been altered by tillage. Crop response, particularly during periods of soil moisture stress, is a useful indicator of the level of sodicity in a soil. Crops grown on soils with varying amounts of sodium exhibit varying heights and stages of development. If the level of sodicity is very high, the crop cannot grow. The effects of sodium on crop growth are influenced by weather conditions, the stage of crop growth, and the soil moisture status. A measure of the effect of sodicity on plant growth is not necessarily a reliable measure of crop yields. In many areas the yields of barley and wheat are affected less than the growth of these crops.

The variability of sodic soils can cause management problems. The sodic soils that have salts within a depth of 16 inches, such as Miranda soils, are generally best suited to native grasses. The soils that have a dense, sodic subsoil near the surface are generally unsuited to small grain and sunflowers.

Timely tillage is an important management need in areas of the leached sodic soils, such as Aberdeen, Cathay, and Cresbard soils. These areas should be tilled and seeded only when the moisture content is favorable. If worked when too wet, the soils puddle and crust. If the soils are tilled when too dry, tillage and seeding implements cannot easily penetrate the soils. Deep plowing and chemical amendments can help to reclaim sodic soils, but they may not be feasible. To be effective, deep tillage should reach to the sodic subsoil and mix several inches of the underlying material with the subsoil and topsoil. Depending on the soil, tillage to a depth of 15 to 36 inches may be needed. Any reclamation of sodic soils is a long-term endeavor. Complete reclamation may never be achieved. Onsite investigation is needed to confirm the feasibility of deep tillage in a particular area.

Saline-sodic soils develop in areas of restricted drainage where salts rise with the water table but where some leaching downward of clay and some saturation with sodium are evident and a dense, sodic subsoil has formed. The saline-sodic soils in Rolette County are those of the Harriet, Miranda, and Stirum series. The management needs and crop responses on these soils

are a combination of those on saline soils and those on sodic soils.

Additional information about management or reclamation of saline and sodic soils is available from the Natural Resources Conservation Service, the North Dakota Agricultural Experiment Station, and the North Dakota Cooperative Extension Service.

Productivity Index

The productivity index is a relative rating of the ability of a particular map unit to produce a particular crop yield in comparison to other map units. The index ranges from 0, which indicates no yield, to 100, which indicates the highest yield. When the index is calculated, the similar and contrasting inclusions are considered as well as the soils specified in the name of the map unit. In Rolette County a productivity index of 100 was considered equal to an average yield of 40 bushels per acre of spring wheat. Multiplying the productivity index by 40 and then dividing the product by 100 will convert the index number to a figure representing the expected average yield per acre. Barnes-Buse loams, 3 to 6 percent slopes, for example, has a productivity index of 65, which when multiplied by 40 and then divided by 100, converts to 26, which is the expected annual yield of spring wheat in bushels per acre for this map unit. (See table 5.)

Pasture Groups

The following paragraphs describe the pasture groups in Rolette County. They specify the production potential under improved management and the representative adapted forage species for each group. The names of the groups are Clayey, Clayey Subsoil, Claypan, Limy Subirrigated, Loamy and Silty, Overflow and Run-on, Saline, Sands, Sandy, Shallow to Gravel, Sodic and Saline, Thin Claypan, Thin Upland, Very Shallow to Gravel, and Wet.

Clayey pasture group. This group of soils has a relatively high content of clay. The production potential is high. Suitable forage species include smooth bromegrass, Russian wildrye, western wheatgrass, green needlegrass, big bluestem, indiangrass, switchgrass, alfalfa, and sweetclover.

Clayey Subsoil pasture group. This group of soils has a subsoil that somewhat restricts root penetration. The production potential is moderately high. Suitable forage species include smooth bromegrass, Russian wildrye, western wheatgrass, green needlegrass, switchgrass, alfalfa, and sweetclover.

Claypan pasture group. This group of soils has a dense subsoil that restricts root penetration. The production potential is low. Suitable forage species include western wheatgrass, tall wheatgrass, intermediate wheatgrass, pubescent wheatgrass, slender wheatgrass, alfalfa, and sweetclover.

Limy Subirrigated pasture group. This group of soils has a highly calcareous subsoil. The production potential is high. Suitable forage species include big bluestem, indiangrass, switchgrass, little bluestem, smooth bromegrass, intermediate wheatgrass, pubescent wheatgrass, tall wheatgrass, slender wheatgrass, sweetclover, and birdsfoot trefoil.

Loamy and Silty pasture group. This group of soils has a subsoil that is permeable to roots. The soils have a relatively high content of silt and clay and a low content of sand. The production potential is high. Suitable forage species include smooth bromegrass, meadow bromegrass, intermediate wheatgrass, pubescent wheatgrass, switchgrass, indiangrass, big bluestem, slender wheatgrass, streambank wheatgrass, alfalfa, and sweetclover.

Overflow and Run-on pasture group. This group of soils is in areas that receive additional moisture because of stream overflow or runoff from the surrounding areas. The production potential is high. Suitable forage species include smooth bromegrass, meadow bromegrass, intermediate wheatgrass, pubescent wheatgrass, Russian wildrye, altai wildrye, western wheatgrass, thickspike wheatgrass, green needlegrass, slender wheatgrass, big bluestem, indiangrass, switchgrass, alfalfa, and sweetclover.

Saline pasture group. This group of soils has enough salts to interfere with plant growth. The production potential is low. Wetness is a problem. Severely affected areas can be improved, particularly during the establishment period, by mulch, which reduces the extent of surface drying and improves seedling emergence. The better suited forage species include tall wheatgrass, slender wheatgrass, western wheatgrass, beardless wildrye, alkali sacaton, alsike clover, and sweetclover.

Sands pasture group. This group of soils has a subsoil that is permeable to roots. The soils have a relatively high content of sand and a low content of silt and clay. The production potential is moderately high. Suitable forage species include sand bluestem, prairie sandreed, switchgrass, green needlegrass, intermediate wheatgrass, pubescent wheatgrass, and alfalfa.

Sandy pasture group. This group of soils has a

subsoil that is permeable to roots. The soils have a relatively high content of sand and a moderate content of silt and clay. The production potential is high. Suitable forage species include green needlegrass, slender wheatgrass, western wheatgrass, intermediate wheatgrass, pubescent wheatgrass, prairie sandreed, sand bluestem, switchgrass, alfalfa, and sweetclover.

Shallow to Gravel pasture group. This group of soils has a substratum that has a relatively high content of sand or sand and gravel at a depth of about 14 to 25 inches. The production potential is moderate. Drought-tolerant forage species grow best. Suitable species include crested wheatgrass, green needlegrass, western wheatgrass, slender wheatgrass, intermediate wheatgrass, pubescent wheatgrass, and alfalfa.

Sodic and Saline pasture group. This group of soils has a subsoil that restricts root penetration and contains enough salts to interfere with plant growth. The production potential is moderately low. Surface mulch reduces the extent of surface drying and improves seedling emergence. Suitable forage species include tall wheatgrass, western wheatgrass, slender wheatgrass, Russian wildrye, beardless wildrye, switchgrass, alkali sacaton, alsike clover, and sweetclover.

Thin Claypan pasture group. This group of soils has a very dense subsoil that severely restricts root penetration and has enough salts to interfere with plant growth. The production potential is very low. The best suited forage species include western wheatgrass, slender wheatgrass, and alfalfa.

Thin Upland pasture group. This group of soils is in areas that allow runoff of precipitation. The soils have a highly calcareous subsoil. Soil blowing and water erosion are management concerns, particularly during the establishment period. The production potential is moderate. Suitable forage species include smooth bromegrass, intermediate wheatgrass, pubescent wheatgrass, western wheatgrass, green needlegrass, little bluestem, prairie sandreed, sideoats grama, sweetclover, and alfalfa.

Very Shallow to Gravel pasture group. This group of soils has a substratum that has a high content of sand or sand and gravel within a depth of 14 inches. The production potential is low. The most drought-tolerant forage species grow best. Suitable species include western wheatgrass, crested wheatgrass, green needlegrass, intermediate wheatgrass, and pubescent wheatgrass.

Wet pasture group. This group of soils is wet. The production potential is very high. The best suited forage species are those that are tolerant of wetness and inundation. Suitable species include reed canarygrass, creeping foxtail, big bluestem, switchgrass, indiangrass, meadow foxtail, and alsike clover.

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 ensures 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 Natural Resources Conservation Service or of the North Dakota Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops *(11)*. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics

of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, or 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.

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 hazard is the 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."

Rangeland

Prepared by A. Dean Chamrad and Anthony D. Miller, range conservationists, Natural Resources Conservation Service.

The native vegetation on rangeland consists of a wide variety of grasses, grasslike plants, forbs, shrubs, and trees. Generally, the plants are suitable for grazing and the plant cover is sufficiently productive to justify grazing. Cultural treatments generally are not used to increase forage production. The composition and production of the plant community are determined by soil, climate, topography, overstory canopy, and grazing management.

In 1990, approximately 30,000 acres in Rolette County, or about 5 percent of the total acreage, was rangeland. In areas where it is properly managed, this rangeland is similar to the presettlement prairie of the late 1800's and early 1900's. Most of the rangeland is in areas of level and nearly level, sandy soils on wind-sculptured lacustrine plains and in areas of rolling to very steep, loamy soils on dissected till plains. The soils are generally unsuited or poorly suited to cultivated crops. In 1990, the farms and ranches in the county had about 21,500 head of cattle, including about 600 milk cows *(16)*.

Because of the relatively short growing season, some farmers and ranchers have established cool-season tame pastures to supplement the forage produced on rangeland and to extend the grazing season in the spring and fall. Generally, large amounts of hay and feed are needed because of long winters. Hay was harvested on about 39,500 acres in 1988 *(16)*.

Range Sites and Condition Classes

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Soils vary in their capacity to produce grasses and other plants suitable for grazing. Soils that produce about the same kinds and amounts of forage are grouped into a range site.

Each range site has a distinctive potential plant community that is referred to as the climax vegetation. The climax vegetation is relatively stable and indicates what the range site is capable of producing. It reproduces itself annually and changes very little as long as the environment remains unchanged. The climax vegetation on the prairie consists of the kinds of plants that grew when the region was settled. It is generally the most productive combination of forage plants that can be grown on the site. When the site is improperly grazed, some of the climax plants decrease

in quantity, while others increase. Also, plants that are not part of the original native plant community may invade the site.

Decreaser plants are the species that decline in quantity under heavy, continuous grazing. They generally are the tallest, most productive grasses and forbs and are the most palatable to livestock.

Increaser plants are the species that increase in quantity under heavy, continuous grazing at the expense of the decreaser species. They generally are the shorter plants or the ones less palatable to livestock.

Invader plants are species that normally are not part of the climax plant community because they cannot compete with the climax vegetation for moisture, nutrients, and light. They invade the site only after the extent of the climax vegetation has been reduced by heavy, continuous grazing. Most invader species have limited value as forage.

Range condition classes indicate the present composition of the plant community on a range site in relation to the climax vegetation. Range condition is expressed as excellent, good, fair, or poor, depending on how much the present plant community resembles the natural plant community. *Excellent* indicates that 76 to 100 percent of the present plant community is the same as the climax vegetation; *good*, 51 to 75 percent; *fair*, 26 to 50 percent; and *poor*, 25 percent or less.

Potential forage production depends on the kind of range site. Current forage production depends on the range condition and the amount of moisture available to the plants during the growing season.

Table 6 shows, for nearly all the soils in the county, the range site and the potential annual production of vegetation in favorable, average, and unfavorable years. Only those soils that are used as rangeland or are suited to rangeland are listed. An explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table also are important.

Potential annual production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, average, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as kind of plant, stage of growth, exposure, amount of shade, recent rains, and unseasonable dry periods.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Good range management keeps the range in excellent or good condition. Water is conserved, yields are improved, and soils are protected. An important management concern is recognizing the changes in the plant community that take place gradually and can be misinterpreted or overlooked. Growth encouraged by heavy rainfall, for example, may lead to the conclusion that the range is in good condition, when actually the plant cover is weedy and the long-term trend is toward lower production. On the other hand, some rangeland that has been grazed closely for a short period may have a degraded appearance that temporarily obscures its quality and ability to recover rapidly.

Rangeland can recover from prolonged overuse if the climax decreaser species have not been completely grazed out. If overgrazing is stopped, enough climax plants generally remain for proper grazing use, deferred grazing, and the grazing system to improve the range condition. In areas where the climax plant community has been destroyed, range seeding can improve the

condition. Seeding the proper climax species also can restore productive rangeland in areas of poor-quality cropland. Brush control, watering facilities, and other mechanical practices are needed to improve the potential of some rangeland. Good management is one of the most overlooked means of improving rangeland. Proper fencing can provide an opportunity to achieve good management.

The following paragraphs describe the range sites in Rolette County. The names of these sites are Clayey, Claypan, Limy Subirrigated, Overflow, Saline Lowland, Sands, Sandy, Sandy Claypan, Shallow to Gravel, Silty, Subirrigated, Thin Claypan, Thin Sands, Thin Upland, Very Shallow, Wet Meadow, and Wetland.

Clayey range site. This site is dominated by a mixture of cool-season, mid grasses and an understory of short grasses. The principal species are western wheatgrass, porcupinegrass, needleandthread, and green needlegrass. The understory plants are blue grama, prairie junegrass, Pennsylvania sedge, and other upland sedges. Forbs, such as western yarrow, scarlet globemallow, and gray sagewort, make up about 5 percent of the total herbage. The most common woody plants are fringed sagebrush, western snowberry, and prairie rose.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as western wheatgrass, porcupinegrass, needleandthread, green needlegrass, and prairie junegrass. The plants that increase in abundance under these conditions are blue grama, fringed sagebrush, and upland sedges. Further deterioration results in a dominance of blue grama, upland sedges, western ragweed, and fringed sagewort or the invasion of Kentucky bluegrass.

Very few problems affect management of this site. The rate of water infiltration is slow. As a result, an adequate cover of vegetation is needed to help ensure that forage production is not reduced by runoff. Areas where the range is in fair condition can generally be restored to good or excellent condition by good management if the remnant climax species remain in sufficient numbers and are evenly distributed.

Claypan range site. The climax vegetation on this site is primarily a mixture of short and mid grasses, sedges, and forbs. The principal species are western wheatgrass, green needlegrass, needleandthread, and prairie junegrass. Other species are blue grama and upland sedges. The most common forbs are scarlet globemallow, silver scurfpea, and rush skeletonplant. Fringed sagewort is a common shrub on this site.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, prairie junegrass, needleandthread, and western wheatgrass. The plants that increase in abundance under these conditions are inland saltgrass, blue grama, Sandberg bluegrass, upland sedges, and fringed sagebrush. Further deterioration results in a dominance of blue grama, inland saltgrass, upland sedges, fringed sagebrush, broom snakeweed, and unpalatable forbs.

This site is easily damaged by overgrazing. Because of a dense subsoil and the content of salts in the soils, reestablishing vegetation is difficult in denuded areas. Careful management that maintains the abundance of the naturally dominant plants is the best way to maintain forage production and protect the soils from water erosion.

Limy Subirrigated range site. Tall grasses dominate this site. The principal species are little bluestem, big bluestem, indiangrass, and switchgrass. Other species are slim sedge, fescue sedge, and Baltic rush. The most common forbs are Maximilian sunflower, stiff sunflower, American licorice, and Missouri goldenrod. They make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, indiangrass, switchgrass, Maximilian sunflower, and stiff sunflower. Little bluestem initially increases in abundance under these conditions, but it eventually decreases. Further deterioration results in a dominance of Kentucky bluegrass, Baltic rush, common spikerush, and low-growing sedges, grasses, and forbs.

Because of the high percentage of warm-season grasses, this site can provide high-quality forage late in the growing season. In areas where the plant community has deteriorated from its potential, deferment of grazing during the growing season or a planned grazing system can restore the site. In areas where the potential plant community has been destroyed by cultivation or by extremely severe overuse, range seeding can reestablish the major species of grasses.

Overflow range site. Both tall and mid grasses are dominant when this site is in excellent condition. The principal species are big bluestem, green needlegrass, western wheatgrass, and needleandthread. Other species are porcupinegrass, switchgrass, fescue sedge, and little bluestem. Several forbs, such as Maximilian sunflower, soft goldenrod, gray sagewort, and heath aster, make up about 10 percent of the total herbage. Several woody plants, such as western snowberry, fringed sagebrush, and common chokecherry, commonly grow on the site.

Continual heavy grazing by cattle results in a

decrease in the abundance of such plants as big bluestem, green needlegrass, prairie dropseed, and switchgrass. The plants that increase in abundance under these conditions are western wheatgrass, blue grama, Pennsylvania sedge, and fescue sedge. Further deterioration results in a dominance of blue grama, sedges, Kentucky bluegrass, and unpalatable forbs.

Because of its position on the landscape, this site frequently is overgrazed. Separate fencing of this site generally is not feasible because of the small size or the shape of the areas. Because it is subject to flooding and receives runoff from the adjacent areas, this site is very productive when properly managed. A planned grazing system can restore the site and maintain a high level of productivity. Reseeding is needed in areas that have been farmed. In areas where shrubs dominate, brush control can help to restore productivity.

Saline Lowland range site. Salt-tolerant, mid grasses dominate this site. The principal species are Nuttall alkaligrass, inland saltgrass, alkali cordgrass, and other salt-tolerant species, including western wheatgrass and slender wheatgrass. Other species are alkali muhly, plains bluegrass, foxtail barley, and prairie bulrush. Forbs, such as western dock, silverweed cinquefoil, and Pursh seepweed, make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as Nuttall alkaligrass, slender wheatgrass, western wheatgrass, and alkali cordgrass. The plants that increase in abundance under these conditions are inland saltgrass, alkali muhly, foxtail barley, and mat muhly. Further deterioration results in a dominance of inland saltgrass, foxtail barley, silverweed cinquefoil, and western dock.

A high content of salts and a restricted available water capacity limit forage production on this site. Careful management of the adapted, desirable salt-tolerant plants can maintain good forage production. If the plant community has been severely damaged, however, the site recovers slowly. Soil blowing and water erosion are hazards in denuded areas. Stock water ponds on this site frequently contain salty water. If feasible, alternative water sources should be developed.

Sands range site. The principal grasses on this site are prairie sandreed, needleandthread, sand bluestem, and sand dropseed. Other species are blue grama, prairie junegrass, little bluestem, western wheatgrass, and upland sedges. Forbs make up about 10 percent of the total herbage. This site has a small amount of woody species, such as prairie rose, western snowberry, and leadplant amorpha.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as prairie sandreed, needleandthread, little bluestem, sand bluestem, and leadplant amorpha. The plants that increase in abundance under these conditions are sand dropseed, blue grama, upland sedges, and several forbs. Further deterioration results in a dominance of blue grama, upland sedges, clubmoss, and unpalatable forbs, such as fringed sagewort, green sagewort, cudweed sagewort, prairie rose, and gray sagewort.

A low or very low available water capacity and the hazard of soil blowing are concerns in managing this site. Measures that minimize the formation of livestock trails and that do not allow the animals to concentrate in an area for too long a time are needed. In severely overgrazed areas, blowouts are common. In areas of large blowouts, shaping, seeding, and mulching are needed before the climax vegetation can be reestablished. The vegetation in areas where the site is in fair or poor condition responds rapidly to improved grazing management.

Sandy range site. The principal grasses on this site are needleandthread and prairie sandreed. Other species are prairie junegrass, blue grama, western wheatgrass, green needlegrass, and upland sedges. The site generally has a number of early season forbs, such as western yarrow, green sagewort, and Missouri goldenrod. Woody plants, such as western snowberry, leadplant amorpha, and prairie rose, make up about 5 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as needleandthread, green needlegrass, prairie sandreed, and leadplant amorpha. The plants that increase in abundance under these conditions are blue grama, upland sedges, sand dropseed, and several forbs. Further deterioration results in a dominance of blue grama, upland sedges, and unpalatable forbs, such as western yarrow, green sagewort, and cudweed sagewort.

A moderate available water capacity is a concern in managing this site. Also, soil blowing is a hazard in denuded areas. Management that maintains the abundance of the key species results in a natural plant community that provides excellent forage for livestock and a protective plant cover.

Sandy Claypan range site. Short grasses dominate this site. The principal species are western wheatgrass, needleandthread, and blue grama. Other species are sun sedge, other upland sedges, and a small number of perennial forbs. The most common woody plants are

silver sagebrush, fringed sagebrush, and western snowberry.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as western wheatgrass and needleandthread. The plants that increase in abundance under these conditions are blue grama, upland sedges, and fringed sagebrush. Further deterioration results in a dominance of blue grama, upland sedges, fringed sagebrush, annual forbs, and annual grasses.

Forage production varies on this site. The soils have a dense, sodic subsoil and a limited available water capacity. The site is fragile, and the natural plant community can deteriorate rapidly. Management that maintains a protective plant cover is needed to control erosion.

Shallow to Gravel range site. A mixture of cool- and warm-season, mid grasses dominates this site. The principal species are western wheatgrass, needleandthread, green needlegrass, and blue grama. Other species are plains muhly, prairie junegrass, red threeawn, porcupinegrass, and upland sedges. Forbs make up about 10 percent of the total herbage. The site has only a small amount of woody plants.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, western wheatgrass, plains muhly, and prairie junegrass. The plants that increase in abundance under these conditions are blue grama, red threeawn, and upland sedges. Further deterioration results in a dominance of blue grama, upland sedges, Kentucky bluegrass, unpalatable forbs, and fringed sagebrush.

Because of a limited available water capacity, forage production is limited on this site. It varies, depending on rainfall patterns. The site is fragile, and the plant community can deteriorate rapidly. Keeping the plant community near its potential and maintaining the vigor of the desirable plants help to optimize the use of the limited amount of available moisture.

Silty range site. Mid grasses dominate this site. The principal species are western wheatgrass, needleandthread, green needlegrass, and blue grama. Other species are prairie junegrass, prairie dropseed, and upland sedges. Forbs make up about 10 percent of the total herbage. The site has minor amounts of weedy species.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, prairie junegrass, needleandthread, western wheatgrass, and porcupinegrass. The plants that increase in abundance under these conditions are western wheatgrass, blue grama, threadleaf sedge, needleleaf sedge, and fringed sagebrush. Further deterioration results in a dominance of blue grama, threadleaf sedge, needleleaf sedge, Kentucky bluegrass, fringed sagebrush, cudweed sagewort, and western snowberry.

Generally, no major problems affect management of this site. In the more sloping areas, however, gullies can form along livestock trails. Fencing and improved grazing management help to prevent gullying. They also are beneficial in areas where gullies have already formed. Areas where the site is in fair condition generally can be restored to good or excellent condition by good management. In some areas brush control is needed.

Subirrigated range site. Tall grasses dominate this site. The principal species are big bluestem, switchgrass, prairie cordgrass, little bluestem, and northern reedgrass. Other species are indiangrass, western wheatgrass, tall dropseed, and slender wheatgrass. The site has minor amounts of sedges and rushes. A variety of forbs makes up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, switchgrass, prairie cordgrass, northern reedgrass, indiangrass, and little bluestem. The plants that increase in abundance under these conditions are mat muhly, fowl bluegrass, Baltic rush, common spikerush, and undesirable forbs. Further deterioration results in a dominance of Kentucky bluegrass, short grasses, grasslike plants, and undesirable forbs.

Because of the high percentage of warm-season grasses, this site can provide high-quality forage late in the growing season. In areas where the plant community has deteriorated from its potential, deferment of grazing during the growing season or a planned grazing system can restore the site. In areas where the potential plant community has been destroyed by cultivation or by extremely severe overuse, range seeding can reestablish the major species of grasses.

Thin Claypan range site. Short grasses dominate this site. The principal species are western wheatgrass, blue grama, inland saltgrass, and Sandburg bluegrass. Other species are prairie junegrass, needleandthread, Nuttall alkaligrass, alkali muhly, and needleleaf sedge. Forbs make up about 5 percent of the total herbage. The most common woody plants are fringed sagebrush and cactus.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as western

wheatgrass, prairie junegrass, and needleandthread. Plants that increase in abundance under these conditions are blue grama, inland saltgrass, Sandberg bluegrass, and alkali muhly. Further deterioration results in a dominance of short grasses, sedges, fringed sagebrush, broom snakeweed, and undesirable forbs.

Because of a high content of salts near the surface of the soils, productivity is quite low on this site. The site produces good-quality forage for cattle only if properly managed. If the site is in poor or fair condition, recovery is quite slow because of the salts and a dense, sodic subsoil. Stock water ponds should not be constructed on this site because the water is likely to be salty. Careful management can maintain or restore the site to good or excellent condition. If the vegetation has been destroyed by cultivation or the site is denuded, range seeding can restore the climax vegetation. Good seeding techniques are needed.

Thin Sands range site. Mid grasses dominate this site. The principal species are prairie sandreed, needleandthread, and sand bluestem. Other species are blue grama, sand dropseed, upland sedges, and prairie junegrass. Forbs make up about 10 percent of the total herbage. The site has minor amounts of woody plants.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as prairie sandreed, needleandthread, and sand bluestem. The plants that increase in abundance under these conditions are sand dropseed and upland sedges. Further deterioration results in a dominance of upland sedges, Kentucky bluegrass, blue grama, and several unpalatable forbs.

This site is very fragile. It is subject to soil blowing if the vegetation is damaged by overgrazing or the soils are denuded. Blowouts are common in overgrazed areas. Good management can keep the site in good or excellent condition. In areas where the site is in poor or fair condition, careful management can restore productivity. A planned grazing system that includes adequate rest periods between the grazing periods is one of the better ways of managing this site.

Thin Upland range site. Mid, cool- and warm-season grasses dominate this site. The principal species are little bluestem, needleandthread, western wheatgrass, and blue grama. Other species are plains muhly, sideoats grama, red threeawn, and upland sedges. Forbs make up about 10 percent of the herbage. The site has minor amounts of woody plants, such as silverberry and western snowberry.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as little bluestem, needleandthread, western wheatgrass, and sideoats grama. The plants that increase in abundance under these conditions are blue grama, red threeawn, upland sedges, and unpalatable forbs. Further deterioration results in a dominance of blue grama, Kentucky bluegrass, upland sedges, fringed sagewort, and silverberry.

Generally, no major problems affect management of this site. In the more sloping areas, however, gullies can form along livestock trails. Fencing and improved grazing management help to prevent gullying. They also are beneficial in areas where gullies have already formed. Soil blowing is a problem in denuded areas. Areas where the site is in fair condition generally can be restored to good or excellent condition by good management. In some areas brush control is needed.

Very Shallow range site. This site has a mixture of cool- and warm-season, mid grasses. The principal species are needleandthread, western wheatgrass, blue grama, and plains muhly. Other species are prairie junegrass, red threeawn, sideoats grama, and upland sedges. Forbs and woody plants make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as needleandthread, western wheatgrass, sideoats grama, and plains muhly. The plants that increase in abundance under these conditions are blue grama, red threeawn, sand dropseed, and upland sedges. Further deterioration results in a dominance of blue grama, red threeawn, upland sedges, and undesirable forbs and shrubs.

Available water capacity is very low on this site. Also, water erosion is a hazard in the more sloping areas. Gullies can form readily along cattle trails and in denuded areas. The site is frequently overgrazed. Once it has deteriorated to fair or poor condition, it recovers slowly because of the very low available water capacity. Productivity can be maintained by careful management of the cool-season, mid grasses and by cross fencing, which helps to control the pattern of livestock traffic.

Wet Meadow range site. Sedges dominate this site. The principal species are slim sedge, wooly sedge, fescue sedge, prairie cordgrass, and northern reedgrass. Other species are Baltic rush, common spikerush, fowl bluegrass, and switchgrass. The most common forbs are Rydberg sunflower, tall white aster, and common wild mint.

Continual heavy grazing by cattle results in a decrease in the abundance of slim sedge, wooly sedge, northern reedgrass, prairie cordgrass, and switchgrass. The plants that increase in abundance under these conditions are fescue sedge, common spikerush, Baltic

rush, mat muhly, and fowl bluegrass. Further deterioration results in a dominance of low-growing sedges, short grasses, western dock, and Canada thistle.

This site is easily damaged when it is wet. Grazing during wet periods results in compaction, trampling, and root shearing. Livestock are attracted to this site because of the supply of moisture. A planned grazing system that includes proper fencing helps to maintain the climax vegetation. The site is an excellent source of high-quality hay.

Wetland range site. Tall grasses dominate this site. The principal species are rivergrass, prairie cordgrass, northern reedgrass, slough sedge, and slim sedge. Other species are American mannagrass, American sloughgrass, Baltic rush, and common spikesedge. The most common forbs are longroot smartweed and waterparsnip.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as rivergrass, slough sedge, prairie cordgrass, and northern reedgrass. The plants that increase in abundance under these conditions are slim sedge, Baltic rush, common spikesedge, and American sloughgrass. Further deterioration results in a dominance of Baltic rush, common spikesedge, and Mexican dock.

This site is easily damaged when it is wet. Grazing during wet periods results in compaction, trampling, and root shearing. Livestock are attracted to this site because of the supply of moisture. A planned grazing system and deferment of grazing during wet periods help to maintain the climax vegetation and the important elements of wetland wildlife habitat.

Woodland, Windbreaks, and Environmental Plantings

Prepared by Bruce C. Wight, forester, Natural Resources Conservation Service.

Rolette County has approximately 64,100 acres of native woodland *(7)*. Of this total, 59,000 acres is in the Turtle Mountains. The rest is in scattered areas around wetlands and lakes throughout the southern half of the county. Trees and shrubs grow to a limited extent along Ox, Mud, and Wolf Creeks. The large area of woodland in the Turtle Mountains consists of Kelvin loam, Metigoshe sandy loam, and Rolla silty clay. The woodland on bottom land consists mainly of Colvin silt loam. The woodland on the fringe of the wetlands and lakes consists mainly of Vallers and Hamerly loams.

Quaking aspen and bur oak are the dominant trees in the Turtle Mountains. Quaking aspen is dominant from the Canadian border to about 2 to 4 miles from the rim of the Turtle Mountains on the south. Green ash, common chokecherry, golden currant, American hazel, paper birch, redosier dogwood, American highbush cranberry, hawthorn, raspberry, boxelder, Saskatoon serviceberry, staghorn sumac, silver buffaloberry, and common snowberry grow in scattered areas throughout the mountains.

The dominant woody plants on bottom land are American elm, green ash, boxelder, and various species of willow. The less common species include cottonwood, common chokecherry, and redosier dogwood. The principal species in the areas of woodland on the fringe of the wetlands are quaking aspen, various species of willow, and redosier dogwood.

The early settlers used the trees for fuel, lumber, and fenceposts. Currently, there is a renewed interest in using the trees for fuel, but the principal uses are for protection and esthetic purposes. The trees protect soils, homes, livestock, wildlife, and watersheds.

Windbreaks have been planted in Rolette County since the early days of settlement. Some of these early plantings were made under the Timber Culture Act. Under this act, 160 acres of land was granted to a homesteader who planted 10 acres to trees. Most of the early plantings were made to protect farmsteads and livestock. In the 1930's, approximately 330 acres was planted to trees and shrubs under the Prairie States Forestry Project of the United States Department of Agriculture, Forest Service.

Since the 1930's, more than 4,000,000 trees have been planted on about 6,200 acres by county farmers and landowners assisted by the Natural Resources Conservation Service and the Rolette County Soil Conservation District. This effort has included nearly 1,700 acres of farmstead windbreaks and 1,400 miles of field windbreaks. Trees and shrubs are still needed around numerous farmsteads, but the major need is for windbreaks that help to protect soils that are highly susceptible to soil blowing.

The following items should be considered before a planting is made—the purpose of the planting, the suitability of the soils and the climate for various species, the location and design of the windbreak, and selection of hardy seedlings. If these items are not considered, a poor or unsuccessful windbreak may result.

The establishment of a windbreak or an environmental planting and the growth of the trees and shrubs also depend on suitable site preparation before planting and adequate maintenance after planting. Grasses and weeds should be eliminated before the trees and shrubs are planted, and the competing ground cover should be controlled for the life of the windbreak. Some replanting may be necessary during

the first 2 years after the trees and shrubs are planted.

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

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

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure 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 Natural Resources Conservation Service or the North Dakota Cooperative Extension Service or from a commercial nursery.

Recreation

Prepared by David D. Dewald, biologist, Natural Resources Conservation Service.

The recreational resources of Rolette County are somewhat limited. Hunting and fishing are the main recreational opportunities available to the residents of the county. Opportunities for fishing and limited primitive camping are available at Carpenter Lake, Dion Lake, Hooker Lake, Lake Upsilon, Gravel Lake, Belcourt Lake, Wheaton Lake, Jarvis Lake, and Gordon Lake. Northern pike, walleye, bluegill, smallmouth bass, crappie, trout, and perch are the main species of game fish in the waters.

The International Peace Gardens have numerous primitive or modern sites available for camping. Four towns in the county have picnicking and limited camping facilities. The county has no State or county parks.

Approximately 20,100 acres managed by the U.S. Fish and Wildlife Service for waterfowl provides opportunities for hunting. The North Dakota State Game and Fish Department manages approximately 6,700 acres of wildlife areas. About 6,900 acres of State school land is open to the public. Many private landowners grant permission to hunt on their land.

The public areas in the county provide opportunities for recreational activities other than hunting. These activities are include hiking, bird-watching, cross-country skiing, and canoeing.

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 sewer lines. 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 recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational 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 and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

Prepared by David D. Dewald, biologist, Natural Resources Conservation Service.

Rolette County is in the prairie pothole region of North Dakota. It has diverse kinds of wildlife habitat. Since settlement, agricultural activity has reduced the quality and quantity of rangeland and wetland wildlife habitat but has increased the amount of openland wildlife habitat. About 5 percent of the original rangeland habitat remains. The diversity of the wildlife habitat is enhanced by the numerous wetlands in the county. Drainage systems installed to improve crop production have removed a significant amount of the original wetland habitat. The remaining wetlands provide habitat for waterfowl and furbearers.

By 1987, private landowners had planted more than 6,200 acres of field and farmstead windbreaks, which provide habitat for resident and migratory wildlife species. Also, private landowners have protected approximately 20,100 acres of wetlands by conveying their drainage rights to the Federal Government through the Small Wetlands Acquisition Program. The landowners manage additional upland and wetland areas primarily for wildlife. The expanded use of no-till farming and conservation tillage systems and the inclusion of grasses and legumes in the cropping system have increased the amount of food and cover for migratory waterfowl and resident wildlife.

The public lands in Rolette County provide excellent wildlife habitat. The U.S. Fish and Wildlife Service manages about 4,900 acres as waterfowl production areas and an additional 4,000 acres as easement refuges. The North Dakota State Game and Fish Department manages approximately 6,700 acres of wildlife areas.

Important game bird species in the county are gray partridge, ruffed grouse, ducks, geese, and mourning dove. The mammals that are hunted include red fox, moose, white-tailed deer, muskrat, mink, raccoon, badger, cottontail rabbit, and white-tailed jackrabbit.

Various fish species inhabit the waters in the county. Northern pike, perch, walleye, crappie, bluegill, smallmouth bass, trout, and bullhead are the major species. Most of the fish are in public waters. The potential for developing additional fishery resources is limited.

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 flooding. 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, flooding, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are intermediate wheatgrass, tall wheatgrass, 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 flooding. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, western wheatgrass, and blue grama.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are common chokecherry, buffaloberry, snowberry, and juneberry.

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, common reedgrass, saltgrass, prairie cordgrass, bulrush, 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. Wildlife attracted to these areas include gray partridge, pheasant, western meadowlark, lark bunting, cottontail, and red fox.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include deer, sharp-tailed grouse, western meadowlark, and sparrow.

About 76,000 acres in Rolette County, or nearly 13 percent of the total acreage, meets the requirements for hydric soils. The map units in the county that display hydric characteristics are listed in this section. Soils that have been artificially drained or otherwise so altered that they no longer support a predominance of hydrophytic vegetation are not identified as hydric soils. The list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4, and the location of each is shown on the detailed maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

64	Arveson loam
66	Arveson loam, wet
450	Colvin silt loam
451	Colvin silt loam, channeled
452	Colvin silt loam, saline
453	Colvin silt loam, wet
601	Eramosh peat
602	Eramosh peat, ponded
883	Hamerly-Tonka-Parnell complex, 0 to 3 percent slopes (Tonka and Parnell parts)
893	Harriet silt loam
939	Hecla-Hamar loamy fine sands, 0 to 3 percent slopes (Hamar part)
1269	Marysland silt loam
1426	Parnell silt loam
1709	Southam silt loam
1727	Stirum fine sandy loam
1871	Vallers loam, saline

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. Ratings are given for 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 should 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 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreational uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. 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 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, shrinking and swelling, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 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.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfill. 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 filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 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 resulting from rapid permeability in 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 should 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 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 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 to 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, a 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 a 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 have a water table at a depth of 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. They 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 high 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 for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and the potential for 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 control 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 soil blowing 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 soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 17.

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 to characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, 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 the heading "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

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. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 17.

Rock fragments 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-

weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

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.

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 and septic tank absorption fields.

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.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The 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 soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Coarse sands, 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 coarse sands, loamy sands, loamy fine sands, loamy very fine sands, and sapric soil material. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.
3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, noncalcareous 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 soil blowing are used.
5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.
6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.
7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.
8. Soils that are not subject to soil blowing because of coarse fragments on the surface or because of surface wetness.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration 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.

If a soil is assigned to two hydrologic groups in table 16, the first letter is for drained areas and the second is for undrained areas.

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 is not considered flooding, nor is water in swamps and marshes.

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, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions (the chance of flooding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); and *frequent* that it occurs often under normal weather conditions (the chance of flooding is more than 50 percent in any year). Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 days to 1 month, and *very long* if more than 1 month. Probable dates are expressed in months. About two-thirds to three-fourths of all flooding occurs during the stated period.

The information about flooding 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 little or no horizon development.

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 estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 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. 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.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. 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.

Engineering Index Test Data

Table 17 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their Morphology." The soil samples were tested by the North Dakota State Highway Department Laboratory.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 422 (ASTM), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 4318 (ASTM); Plasticity index—T 90 (AASHTO), D 4318 (ASTM); and Moisture density—T 99 (AASHTO), D 698 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(12)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

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

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Boroll (*Bor*, meaning cool, 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 Haploborolls (*Hapl*, meaning minimal horizonation, plus *boroll*, the suborder of the Mollisols that has a frigid temperature).

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 *Udic* identifies the subgroup that has a udic moisture regime. An example is Udic Haploborolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, 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 Udic Haploborolls.

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. 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" *(14)*. Many of the technical terms used in the descriptions are defined in "Soil Taxonomy" *(12)*. 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."

Aberdeen Series

The Aberdeen series consists of very deep, moderately well drained, slowly permeable, sodic soils

on lake plains. These soils formed in glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Aberdeen silt loam, in an area of Aberdeen-Nahon silt loams, 510 feet west and 175 feet north of the southeast corner of sec. 22, T. 159 N., R. 72 W.

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

B/E—7 to 10 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry (B); dark gray (10YR 4/1) E material, gray (10YR 5/1) dry; strong medium prismatic structure parting to moderate fine subangular blocky; very hard and very firm; very sticky and very plastic; common very fine roots; many faint clay films on faces of peds; neutral; clear smooth boundary.

Btn—10 to 18 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to strong fine subangular blocky; very hard and very firm; very sticky and very plastic; few very fine roots; continuous distinct clay films on faces of peds and lining pores; moderately alkaline; gradual wavy boundary.

Bk—18 to 25 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; hard and firm; sticky and plastic; few very fine roots; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

BCky—25 to 42 inches; olive brown (2.5Y 4/4) silt loam, pale yellow (2.5Y 7/4) dry; many fine distinct gray (10YR 5/1) mottles; weak medium subangular blocky structure; hard and firm; sticky and plastic; common large masses of gypsum crystals; lime disseminated throughout; strong effervescence; slightly alkaline; gradual wavy boundary.

C—42 to 60 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; many medium prominent grayish brown (10YR 5/2) mottles; massive; hard and firm; sticky and plastic; strong effervescence; moderately alkaline.

The A horizon has value of 2 or 3 (3 or 4 dry). The B/E horizon has value of 3 or 4 (4 or 5 dry) and chroma of 1 or 2. The Btn horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1 to 3. It is silty clay loam or silty clay. The C horizon has value of 4 to 6 (5 to 8 dry) and chroma of 2 to 4. It is silt loam or silty clay loam.

Arveson Series

The Arveson series consists of very deep, poorly drained and very poorly drained, moderately rapidly permeable, highly calcareous soils on outwash plains and lake plains. These soils formed in glaciofluvial and glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Arveson loam, 1,130 feet west and 500 feet south of the northeast corner of sec. 31, T. 160 N., R. 71 W.

Ag—0 to 8 inches; black (5Y 2/1) loam, dark gray (5Y 4/1) dry; weak fine subangular blocky structure; soft and friable; slightly sticky and slightly plastic; many very fine and fine and few medium roots; strong effervescence; slightly alkaline; clear smooth boundary.

ABkg—8 to 16 inches; very dark gray (5Y 3/1) loam, gray (5Y 5/1) dry; moderate medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; many very fine and fine and few medium roots; lime disseminated throughout; violent effervescence; slightly alkaline; clear wavy boundary.

Bkg—16 to 26 inches; very dark gray (5Y 3/1) fine sandy loam, gray (5Y 5/1) dry; weak coarse prismatic structure parting to moderate medium and coarse subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; common very fine and fine and few medium roots; common medium irregularly shaped soft masses of lime; violent effervescence; slightly alkaline; gradual wavy boundary.

Cg1—26 to 32 inches; olive gray (5Y 5/2) loamy fine sand, light gray (5Y 7/1) dry; few fine faint olive (5Y 5/3) mottles; single grain; soft and very friable; nonsticky and nonplastic; few very fine and fine roots; slight effervescence; slightly alkaline; gradual wavy boundary.

Cg2—32 to 42 inches; olive gray (5Y 5/2) fine sand, light gray (5Y 7/2) dry; many medium distinct olive (5Y 4/4) mottles; single grain; loose; nonsticky and nonplastic; very slight effervescence; slightly alkaline; gradual wavy boundary.

Cg3—42 to 60 inches; olive gray (5Y 4/2) fine sand, light olive gray (5Y 6/2) dry; many large distinct olive (5Y 5/4) mottles; single grain; loose; nonsticky and nonplastic; very slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 24 inches. The A horizon has hue of 10YR to 5Y and value of 3 to 6 dry. The Bk horizon has hue of 2.5Y or 5Y or is neutral in hue. It has value of 3 to 6 (4 to 8 dry) and chroma of 0 to 2. The C horizon has hue of 2.5Y or

5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 or 2. It is loamy fine sand, fine sand, sand, or coarse sand. Some pedons have an Ab horizon, which is 1 to 4 inches thick.

Arvilla Series

The Arvilla series consists of very deep, somewhat excessively drained soils on outwash plains (fig. 10). These soils formed in glaciofluvial deposits. Permeability is moderately rapid in the upper part of the profile and very rapid in the lower part. Slope ranges from 0 to 6 percent.

Typical pedon of Arvilla sandy loam, 0 to 6 percent slopes, 1,850 feet south and 1,320 feet east of the northwest corner of sec. 6, T. 161 N., R. 72 W.

Ap—0 to 5 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak medium and fine granular structure; soft and very friable; slightly sticky and slightly plastic; common very fine roots; about 5 percent gravel; slightly alkaline; clear smooth boundary.

A—5 to 10 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; common very fine roots; about 5 percent gravel; moderately alkaline; gradual wavy boundary.

Bw—10 to 16 inches; dark brown (10YR 4/3) sandy loam, brown (10YR 5/3) dry; weak medium prismatic structure parting to moderate medium subangular blocky; soft and very friable; slightly sticky and slightly plastic; common very fine roots; about 5 percent gravel; slightly alkaline; abrupt smooth boundary.

2Bk—16 to 31 inches; dark brown (10YR 4/3) gravelly coarse sand, pale brown (10YR 6/3) dry; single grain; loose; nonsticky and nonplastic; about 30 percent gravel; lime coatings on the underside of pebbles; strong effervescence; moderately alkaline; gradual wavy boundary.

2C—31 to 60 inches; dark brown (10YR 4/3) gravelly coarse sand, pale brown (10YR 6/3) dry; single grain; loose; nonsticky and nonplastic; about 30 percent gravel; slight effervescence; slightly alkaline.

The depth to sand and gravel ranges from 14 to 25 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 3 or 4 (3 to 5 dry) and chroma of 1 to 3. The content of gravel in the 2C horizon ranges from 20 to 35 percent.

Barnes Series

The Barnes series consists of very deep, well drained, moderately slowly permeable soils on till plains and moraines. These soils formed in glacial till. Slope ranges from 0 to 25 percent.

Typical pedon of Barnes loam, in an area of Barnes-Buse loams, 3 to 6 percent slopes, 2,000 feet west and 1,000 feet south of the northeast corner of sec. 28, T. 160 N., R. 69 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few fine and very fine roots; about 1 percent gravel; neutral; abrupt smooth boundary.

Bw1—6 to 10 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few fine and very fine roots; about 1 percent gravel; neutral; clear smooth boundary.

Bw2—10 to 18 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few fine roots; about 1 percent gravel; neutral; clear smooth boundary.

Bk1—18 to 26 inches; yellowish brown (10YR 5/4) loam, light yellowish brown (10YR 6/4) dry; weak medium prismatic structure; slightly hard and friable; slightly sticky and slightly plastic; few fine roots; about 2 percent gravel; many medium irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

Bk2—26 to 32 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; weak medium prismatic structure; slightly hard and friable; slightly sticky and slightly plastic; few fine roots; about 2 percent gravel; few fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C—32 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; hard and firm; slightly sticky and slightly plastic; about 3 percent gravel; few fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline.

The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 2 to 5 (4 to 6 dry) and chroma 2 to 4. The Bk horizon has value of 4 to 6 (5 to 7 dry) and chroma of 2 to 4. The C horizon has hue of 10YR

or 2.5Y, value of 4 to 6 (4 to 7 dry), and chroma of 2 to 4.

Bearden Series

The Bearden series consists of very deep, somewhat poorly drained, moderately slowly permeable, highly calcareous soils on lake plains. These soils formed in glaciolacustrine deposits. Slope ranges from 0 to 3 percent.

Typical pedon of Bearden silt loam, 2,130 feet west and 400 feet north of the southeast corner of sec. 3, T. 159 N., R. 72 W.

Ap—0 to 5 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to moderate medium granular; slightly hard and friable; sticky and plastic; common very fine roots; very slight effervescence; slightly alkaline; abrupt smooth boundary.

A—5 to 11 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate coarse prismatic structure parting to moderate medium and coarse subangular blocky; slightly hard and friable; sticky and plastic; few very fine roots; very slight effervescence; slightly alkaline; clear smooth boundary.

Bk—11 to 20 inches; brown (10YR 5/3) silt loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; hard and firm; sticky and plastic; few very fine roots; lime disseminated throughout; violent effervescence; moderately alkaline; clear wavy boundary.

Bky—20 to 31 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; moderate medium subangular blocky structure; hard and firm; sticky and plastic; few very fine roots; few medium masses of gypsum crystals; lime disseminated throughout; strong effervescence; moderately alkaline; clear wavy boundary.

BCky—31 to 47 inches; olive (5Y 4/3) silt loam, pale yellow (5Y 7/3) dry; few fine distinct gray (5Y 5/1) mottles; weak medium and coarse subangular blocky structure; hard and firm; sticky and plastic; few medium masses of gypsum crystals; slight effervescence; moderately alkaline; clear wavy boundary.

C—47 to 60 inches; olive (5Y 5/3) silt loam, pale yellow (5Y 7/3) dry; few fine faint olive gray (5Y 5/2) and few medium distinct olive (5Y 5/4) mottles; massive; hard and firm; sticky and plastic; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 20 inches. In some pedons the soils are saline.

The Ap horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3 (3 to 5 dry) and chroma of 0 or 1. The Bk horizon has hue of 10YR to 5Y, value of 3 to 5 (5 to 7 dry), and chroma of 1 to 4. It is silt loam or silty clay loam. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It is silt loam or silty clay loam.

Bottineau Series

The Bottineau series consists of very deep, well drained, moderately slowly permeable soils on till plains and moraines. These soils formed in glacial till. Slope ranges from 3 to 25 percent.

Typical pedon of Bottineau loam, 9 to 25 percent slopes, 1,900 feet north and 50 feet east of the southwest corner of sec. 14, T. 162 N., R. 72 W.

Oi—2 inches to 0; undecomposed leaves and twigs; clear smooth boundary.

A—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure parting to moderate fine and medium granular; slightly hard and friable; slightly sticky and slightly plastic; common uncoated sand grains on faces of peds; slightly acid; clear irregular boundary.

Bt1—7 to 13 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; strong fine and medium angular blocky structure; hard and firm; sticky and plastic; common faint clay films on faces of peds; very dark gray (10YR 3/1) organic coatings; many uncoated sand grains on faces of peds; slightly acid; clear irregular boundary.

Bt2—13 to 18 inches; dark grayish brown (10YR 4/2) clay loam, light brownish gray (10YR 6/2) dry; weak medium prismatic structure parting to strong fine and medium angular blocky; hard and firm; sticky and plastic; many distinct clay films of faces of peds; very dark gray (10YR 3/1) organic coatings; common uncoated sand grains on faces of peds; neutral; clear wavy boundary.

Bt3—18 to 25 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; moderate medium and coarse prismatic structure parting to strong fine and medium angular blocky; very hard and firm; sticky and plastic; common distinct clay films on faces of peds; common uncoated sand grains on faces of peds; about 2 percent gravel; slightly alkaline; clear wavy boundary.

Btk—25 to 43 inches; olive brown (2.5Y 4/4) clay loam, light brownish gray (2.5Y 6/2) dry; weak very coarse prismatic structure; hard and friable; sticky and plastic; common faint clay films on faces of peds; about 5 percent gravel; common fine irregularly

shaped soft masses of lime; violent effervescence; slightly alkaline; gradual wavy boundary.

C—43 to 60 inches; olive brown (2.5Y 4/4) clay loam, light brownish gray (2.5Y 6/2) dry; massive; hard and friable; sticky and plastic; about 7 percent gravel; common fine irregularly shaped soft masses of lime; strong effervescence; slightly alkaline.

The A horizon has value of 2 or 3 (3 or 4 dry). The Bt horizon has value of 2 to 5 (4 to 6 dry) and chroma of 1 to 4. Some pedons do not have a Btk horizon. Some have a BCk horizon. The C horizon has value of 4 or 5 (6 or 7 dry).

Buse Series

The Buse series consists of very deep, well drained, moderately slowly permeable soils on till plains and moraines. These soils formed in glacial till. Slope ranges from 3 to 25 percent.

Typical pedon of Buse loam, in an area of Barnes-Buse loams, 3 to 6 percent slopes, 390 feet east and 1,060 feet north of the southwest corner of sec. 33, T. 160 N., R. 69 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate fine granular structure; slightly hard and friable; slightly sticky and slightly plastic; many very fine roots; about 3 percent gravel; slight effervescence; slightly alkaline; abrupt smooth boundary.

Bk1—7 to 20 inches; pale brown (10YR 6/3) loam, very pale brown (10YR 7/3) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; about 3 percent gravel; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk2—20 to 37 inches; yellowish brown (10YR 5/4) loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; about 7 percent gravel; few fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; clear wavy boundary.

C—37 to 60 inches; dark grayish brown (10YR 4/2) and dark brown (10YR 4/3) loam, grayish brown (10YR 5/2) and brown (10YR 5/3) dry; massive; hard and firm; slightly sticky and plastic; about 7 percent gravel; slight effervescence; moderately alkaline.

The Ap horizon has value of 2 or 3 (3 to 5 dry). The Bk and C horizons have hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4.

Cathay Series

The Cathay series consists of very deep, moderately well drained, slowly permeable, sodic soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Cathay loam, in an area of Cathay-Larson loams, 0 to 6 percent slopes, 250 feet south and 675 feet west of the northeast corner of sec. 29, T. 159 N., R. 71 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common fine and very fine roots; neutral; abrupt smooth boundary.

E—7 to 9 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to weak thin platy; soft and very friable; slightly sticky and slightly plastic; few fine and very fine roots; neutral; abrupt smooth boundary.

B/E—9 to 12 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry (B); very dark grayish brown (10YR 3/2) E material, grayish brown (10YR 5/2) dry; moderate medium prismatic structure parting to strong fine angular blocky; very hard and very firm; sticky and plastic; few fine roots compressed on faces of peds; common distinct clay films on faces of peds; neutral; abrupt smooth boundary.

Btn1—12 to 15 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to strong fine angular blocky; very hard and very firm; sticky and plastic; few fine roots; common distinct clay films on faces of peds; neutral; clear wavy boundary.

Btn2—15 to 18 inches; dark brown (10YR 3/3) clay loam, brown (10YR 4/3) dry; moderate medium prismatic structure parting to strong fine angular blocky; very hard and very firm; sticky and plastic; few fine roots; common distinct clay films on faces of peds; slight effervescence; neutral; clear wavy boundary.

Bky—18 to 31 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; moderate medium prismatic structure; hard and firm; slightly sticky and slightly plastic; few fine roots; about 2 percent gravel; common fine irregularly shaped masses of gypsum crystals; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C—31 to 60 inches; olive brown (2.5Y 4/4) loam, light olive brown (2.5Y 5/4) dry; few fine prominent dark yellowish brown (10YR 4/6) mottles; massive; hard and firm; slightly sticky and slightly plastic; about 5 percent gravel; few fine irregularly shaped soft masses of lime; strong effervescence; strongly alkaline.

The Ap horizon has value of 2 or 3 (3 or 4 dry). The B/E horizon has value of 3 or 4 (4 to 6 dry) and chroma of 1 or 2. It is loam or clay loam. The Btn horizon has value of 3 or 4 (3 to 5 dry) and chroma of 1 to 3. It is loam or clay loam. The C horizon has value of 3 to 5 (4 to 6 dry) and chroma of 2 to 4.

Cavour Series

The Cavour series consists of very deep, moderately well drained, very slowly permeable, sodic soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Cavour loam, in an area of Cavour-Cresbard loams, 0 to 6 percent slopes, 730 feet west and 410 feet north of the southeast corner of sec. 29, T. 161 N., R. 72 W.

Ap—0 to 5 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium and fine granular structure; soft and very friable; slightly sticky and slightly plastic; common fine and very fine roots; about 2 percent gravel; neutral; abrupt smooth boundary.

E—5 to 7 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; strong medium platy structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; slightly alkaline; abrupt smooth boundary.

Btn—7 to 17 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; strong coarse columnar structure; extremely hard and very firm; sticky and plastic; common very fine roots compressed on faces of peds; continuous prominent clay films on faces of peds and lining pores; common black (10YR 2/1) organic coatings on faces of peds; grayish brown (10YR 5/2) sand and silt grains on the top of columns; about 2 percent gravel; strongly alkaline; clear wavy boundary.

Bky1—17 to 23 inches; brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; common fine faint dark yellowish brown (10YR 4/4) mottles; moderate coarse prismatic structure parting to moderate coarse subangular blocky; very hard and firm; sticky and plastic; few very fine roots; about 4 percent gravel; common medium masses of gypsum crystals; few fine irregularly shaped soft masses of lime; strong effervescence; strongly alkaline; gradual wavy boundary.

Bky2—23 to 39 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; few fine prominent dark yellowish brown (10YR 3/4) mottles; moderate medium subangular blocky structure; hard and firm; sticky and plastic; about 6 percent gravel; common medium masses of gypsum crystals; few medium irregularly shaped soft masses of lime; strong effervescence; strongly alkaline; clear wavy boundary.

C—39 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; common fine prominent dark yellowish brown (10YR 4/6) and common fine prominent gray (5Y 5/1) mottles; massive; hard and firm; sticky and plastic; about 6 percent gravel; violent effervescence; strongly alkaline.

The Ap horizon has value of 2 or 3 (3 to 5 dry). The E horizon has value of 3 to 5 (5 to 7 dry) and chroma of 1 or 2. The Btn horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5 (5 to 7 dry), and chroma of 1 to 4.

Claire Series

The Claire series consists of very deep, excessively drained, rapidly permeable soils on outwash plains. These soils formed in glaciofluvial deposits. Slope ranges from 6 to 25 percent.

Typical pedon of Claire coarse sand, in an area of Claire-Lohnes complex, 6 to 25 percent slopes, 1,910 feet south and 700 feet east of the northwest corner of sec. 6, T. 159 N., R. 72 W.

Ap—0 to 4 inches; very dark grayish brown (10YR 3/2) coarse sand, grayish brown (10YR 5/2) dry; weak fine granular structure parting to single grain; loose; nonsticky and nonplastic; common very fine roots; about 10 percent gravel; strong effervescence; slightly alkaline; abrupt smooth boundary.

C1—4 to 8 inches; brown (10YR 5/3) coarse sand, pale brown (10YR 6/3) dry; single grain; loose; nonsticky and nonplastic; few very fine roots; about 12 percent gravel; strong effervescence; slightly alkaline; clear smooth boundary.

C2—8 to 32 inches; dark brown (10YR 4/3) coarse sand, brown (10YR 5/3) dry; single grain; loose; nonsticky and nonplastic; about 12 percent gravel; slight effervescence; slightly alkaline; clear smooth boundary.

C3—32 to 60 inches; dark brown (10YR 4/3) sand, pale brown (10YR 6/3) dry; single grain; loose; nonsticky

and nonplastic; about 4 percent gravel; slight effervescence; slightly alkaline.

The A horizon has value of 2 to 4 (4 to 6 dry) and chroma of 1 or 2. The C horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 1 to 4.

Colvin Series

The Colvin series consists of very deep, poorly drained and very poorly drained, moderately slowly permeable, highly calcareous soils on lake plains, till plains, and flood plains. These soils formed in glaciolacustrine deposits and alluvium. Slope is 0 to 1 percent.

Typical pedon of Colvin silt loam, channeled, 2,000 feet west and 300 feet south of the northeast corner of sec. 30, T. 163 N., R. 69 W.

A—0 to 12 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to moderate fine granular; soft and very friable; slightly sticky and slightly plastic; few very fine, fine, and medium roots; slight effervescence; slightly alkaline; clear smooth boundary.

Bkg1—12 to 21 inches; gray (5Y 5/1) silt loam, light gray (5Y 7/1) dry; moderate fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few fine and very fine roots; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Bkg2—21 to 33 inches; light olive gray (5Y 6/2) silt loam, white (5Y 8/2) dry; many fine prominent light yellowish brown (10YR 6/4) mottles; moderate fine subangular blocky structure; hard and friable; slightly sticky and slightly plastic; lime disseminated throughout; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg—33 to 60 inches; pale olive (5Y 6/3) silt loam, pale yellow (5Y 7/3) dry; many fine prominent grayish brown (10YR 5/2) mottles; massive; hard and friable; slightly sticky and slightly plastic; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 24 inches. In some pedons the soils are saline.

The A horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3 (3 or 4 dry) and chroma of 0 or 1. The Bkg horizon has hue of 2.5Y or 5Y or is neutral in hue. It has value of 3 to 6 (5 to 8 dry) and chroma of 0 to 2. It is silt loam or silty clay loam. The Cg horizon has hue of 2.5Y or 5Y, value of 3 to 6 (5 to 7 dry), and chroma of 1 to 3. It has few to many mottles. It is silt loam or silty clay loam.

Cresbard Series

The Cresbard series consists of very deep, moderately well drained, slowly permeable, sodic soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Cresbard loam, in an area of Barnes-Cresbard loams, 3 to 6 percent slopes, 1,700 feet west and 260 feet north of the southeast corner of sec. 29, T. 160 N., R. 69 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few fine and very fine roots; about 2 percent gravel; neutral; abrupt smooth boundary.

E—7 to 9 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak medium platy structure parting to weak medium subangular blocky; slightly hard and very friable; slightly sticky and slightly plastic; few fine roots; about 2 percent gravel; neutral; abrupt wavy boundary.

B/E—9 to 11 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry (B); very dark grayish brown (10YR 3/2) E material, grayish brown (10YR 5/2) dry; moderate medium prismatic structure parting to moderate medium angular blocky; hard and firm; sticky and plastic; few fine roots; few faint clay films on faces of peds; about 2 percent gravel; neutral; clear wavy boundary.

Btn1—11 to 19 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to moderate medium and fine angular blocky; very hard and very firm; sticky and plastic; few fine roots; many distinct clay films on faces of peds and lining pores; common black (10YR 2/1) organic coatings on faces of peds; about 4 percent gravel; neutral; clear wavy boundary.

Btn2—19 to 27 inches; dark brown (10YR 3/3) clay loam, brown (10YR 5/3) dry; moderate medium prismatic structure parting to moderate medium angular blocky; very hard and very firm; sticky and plastic; few fine roots; few faint clay films on faces of peds; about 6 percent gravel; moderately alkaline; gradual wavy boundary.

Bk—27 to 44 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; few fine distinct dark yellowish brown (10YR 4/6) mottles; weak medium prismatic structure; hard and firm; slightly sticky and slightly plastic; few fine roots; about 7 percent gravel; common fine irregularly shaped soft masses of lime; strong effervescence;

slightly alkaline; gradual wavy boundary.
C—44 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct dark yellowish brown (10YR 4/6) mottles; massive; hard and firm; slightly sticky and slightly plastic; about 7 percent gravel; slight effervescence; moderately alkaline.

The A horizon has value of 2 or 3 (3 or 4 dry). The E horizon is 0 to 4 inches thick. The B/E horizon has value of 2 or 3 and chroma of 1 or 2. The Btn horizon has value of 2 to 4 (3 to 5 dry) and chroma of 1 to 3. The C horizon has value of 4 to 6 (5 to 7 dry) and chroma of 2 to 4.

Dickey Series

The Dickey series of very deep, well drained soils on till plains and moraines. These soils formed in eolian material and glacial till. Permeability is rapid in the upper part of the profile and moderate in the lower part. Slope ranges from 3 to 25 percent.

Typical pedon of Dickey loamy fine sand, in an area of Dickey-Esmond complex, 3 to 9 percent slopes, 120 feet west and 1,400 feet south of the northeast corner of sec. 16, T. 159 N., R. 72 W.

Ap—0 to 5 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine and medium granular structure; soft and very friable; nonsticky and nonplastic; common very fine and few fine roots; neutral; clear wavy boundary.
Bw1—5 to 13 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; soft and very friable; nonsticky and nonplastic; common very fine and few fine roots; neutral; gradual wavy boundary.
Bw2—13 to 32 inches; dark brown (10YR 4/3) fine sand, brown (10YR 5/3) dry; weak medium subangular blocky structure; loose; nonsticky and nonplastic; few very fine roots; neutral; clear smooth boundary.
2Bk—32 to 46 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; weak medium and coarse subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; about 5 percent gravel; many fine soft masses of lime; strong effervescence; slightly alkaline; clear wavy boundary.
2C—46 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; slightly hard and friable; slightly sticky and slightly plastic; about 6 percent gravel; common fine soft filaments of lime; slight effervescence; slightly alkaline.

Depth to the 2Bk horizon ranges from 20 to 40 inches. The thickness of the mollic epipedon ranges from 10 to 16 inches.

The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 3 to 5 (4 or 5 dry) and chroma of 1 to 3. The 2Bk horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 2 to 4. The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 8 dry), and chroma of 2 to 4.

Divide Series

The Divide series consists of very deep, somewhat poorly drained, highly calcareous soils on outwash plains. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and very rapid in the lower part. Slope is 0 to 1 percent.

Typical pedon of Divide loam, 540 feet south and 480 feet east of the northwest corner of sec. 3, T. 161 N., R. 69 W.

Ap—0 to 4 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate fine granular structure; soft and very friable; slightly sticky and slightly plastic; few very fine roots; about 6 percent gravel; strong effervescence; moderately alkaline; abrupt smooth boundary.
A—4 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; about 6 percent gravel; strong effervescence; moderately alkaline; abrupt smooth boundary.
Bk1—8 to 19 inches; gray (5Y 5/1) and very dark gray (5Y 3/1) loam, light gray (5Y 7/1) and gray (5Y 5/1) dry; moderate medium and coarse subangular blocky structure; slightly hard and friable; slightly sticky and plastic; few very fine roots; about 6 percent gravel; lime disseminated throughout; strong effervescence; moderately alkaline; clear wavy boundary.
Bk2—19 to 25 inches; olive gray (5Y 5/2) gravelly loam, light gray (5Y 7/2) dry; few medium faint olive (5Y 5/3) mottles; weak medium and coarse subangular blocky structure; slightly hard and friable; slightly sticky and plastic; few very fine roots; about 16 percent gravel; lime disseminated throughout; strong effervescence; moderately alkaline; clear smooth boundary.
2C1—25 to 45 inches; olive (5Y 5/3) gravelly sand, pale yellow (5Y 7/3) dry; single grain; loose; nonsticky and nonplastic; about 22 percent gravel; slight

effervescence; moderately alkaline; clear wavy boundary.

2C2—45 to 60 inches; olive (5Y 4/3) gravelly coarse sand, pale yellow (5Y 7/3) dry; common large faint olive (5Y 5/3) mottles; single grain; loose; nonsticky and nonplastic; about 20 percent gravel; slight effervescence; moderately alkaline.

Depth to the 2C horizon ranges from 20 to 40 inches. The A horizon has hue of 10YR or 2.5Y and value of 2 or 3 (3 to 5 dry). The Bk horizon has hue of 10YR to 5Y, value of 3 to 7 (5 to 8 dry), and chroma of 1 to 4. The 2C horizon has hue of 10YR to 5Y, value of 5 to 7 dry, and chroma of 2 to 6. It is very gravelly loamy sand, coarse sand, gravelly coarse sand, gravelly sand, or sand. Some pedons have a 3C horizon of loam below a depth of 40 inches.

Eckman Series

The Eckman series consists of very deep, well drained, moderately permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slope ranges from 1 to 6 percent.

Typical pedon of Eckman silt loam, 1 to 6 percent slopes, 2,240 feet east and 2,550 feet north of the southwest corner of sec. 4, T. 159 N., R. 72 W.

Ap—0 to 5 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to moderate fine granular; soft and very friable; slightly sticky and slightly plastic; common very fine roots; neutral; clear smooth boundary.

A—5 to 11 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak coarse prismatic structure parting to moderate medium and coarse subangular blocky; soft and very friable; slightly sticky and slightly plastic; few very fine roots; slightly alkaline; gradual wavy boundary.

Bw—11 to 16 inches; dark brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; weak coarse prismatic structure parting to moderate medium and coarse subangular blocky; soft and very friable; slightly sticky and slightly plastic; few very fine roots; neutral; clear smooth boundary.

Bk—16 to 32 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; moderate medium and coarse subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; few very fine roots; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—32 to 48 inches; light olive brown (2.5Y 5/4) very fine sandy loam, light yellowish brown (2.5Y 6/4) dry; weak medium and coarse subangular blocky structure; soft and very friable; nonsticky and slightly plastic; slight effervescence; moderately alkaline; clear smooth boundary.

C2—48 to 60 inches; light olive brown (2.5Y 5/4) loamy very fine sand, pale yellow (2.5Y 7/4) dry; massive; soft and very friable; nonsticky and nonplastic; slight effervescence; moderately alkaline.

The A horizon has value of 3 to 5 dry and chroma of 1 or 2. The Bw horizon has value of 3 to 5 (4 to 6 dry) and chroma of 2 to 4. The Bk and C horizons have hue of 2.5Y or 10YR, value of 5 or 6 (6 to 8 dry), and chroma of 2 to 4. The C horizon is silt loam, very fine sandy loam, or loamy very fine sand.

Egeland Series

The Egeland series consists of very deep, well drained, moderately rapidly permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slope ranges from 0 to 6 percent.

Typical pedon of Egeland fine sandy loam, 0 to 6 percent slopes, 630 feet east and 120 feet south of the northwest corner of sec. 20, T. 160 N., R. 73 W.

Ap—0 to 8 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; moderate medium and fine granular structure; soft and friable; slightly sticky and slightly plastic; many very fine roots; neutral; clear wavy boundary.

Bw—8 to 15 inches; dark brown (10YR 4/3) fine sandy loam, brown (10YR 5/3) dry; moderate coarse prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; slightly alkaline; clear wavy boundary.

Bk—15 to 33 inches; brown (10YR 5/3) fine sandy loam, very pale brown (10YR 7/3) dry; weak coarse prismatic structure parting to moderate medium and coarse subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; lime disseminated throughout; violent effervescence; moderately alkaline; clear wavy boundary.

BCk—33 to 57 inches; dark brown (10YR 4/3) loamy fine sand, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; soft and very friable; nonsticky and nonplastic; few fine irregularly shaped soft masses of lime; strong effervescence; slightly alkaline; clear wavy boundary.

C—57 to 60 inches; dark brown (10YR 4/3) loamy fine sand, pale brown (10YR 6/3) dry; massive; soft and very friable; nonsticky and nonplastic; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 8 to 16 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 3 or 4 (4 or 5 dry) and chroma of 2 to 4. The C horizon has hue of 2.5Y or 10YR, value of 4 or 5 (5 to 7 dry), and chroma of 2 to 4.

Embden Series

The Embden series consists of very deep, moderately well drained, moderately rapidly permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Embden fine sandy loam, 2,310 feet north and 80 feet east of the southwest corner of sec. 19, T. 159 N., R. 73 W.

Ap—0 to 6 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; moderate medium granular structure; soft and very friable; slightly sticky and slightly plastic; few very fine roots; neutral; abrupt smooth boundary.

A—6 to 16 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; moderate coarse prismatic structure parting to moderate fine subangular blocky; soft and very friable; slightly sticky and slightly plastic; few very fine roots; neutral; gradual wavy boundary.

Bw—16 to 27 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak coarse prismatic structure parting to moderate fine subangular blocky; soft and very friable; slightly sticky and slightly plastic; few very fine roots; slightly alkaline; clear wavy boundary.

Bk1—27 to 35 inches; grayish brown (2.5Y 5/2) fine sandy loam, light gray (2.5Y 7/2) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard and very friable; slightly sticky and slightly plastic; common fine soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk2—35 to 43 inches; pale olive (5Y 6/3) fine sandy loam, pale yellow (5Y 7/3) dry; few fine faint olive (5Y 5/4) mottles; moderate medium and coarse subangular blocky structure; slightly hard and very friable; slightly sticky and slightly plastic; few fine soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—43 to 54 inches; olive (5Y 5/3) loamy fine sand, pale olive (5Y 6/3) dry; few fine faint olive (5Y 5/4) mottles; single grain; loose; nonsticky and nonplastic; strong effervescence; slightly alkaline; clear smooth boundary.

C2—54 to 60 inches; olive (5Y 5/3) loamy fine sand, pale olive (5Y 6/3) dry; common fine faint olive gray (5Y 5/2) mottles; single grain; loose; nonsticky and nonplastic; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 16 to 40 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. The C horizon has hue of 10YR to 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4.

Emrick Series

The Emrick series consists of very deep, moderately well drained, moderately permeable soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Emrick loam, in an area of Heimdal-Emrick loams, 0 to 3 percent slopes, 1,770 feet north and 1,630 feet west of the southeast corner of sec. 32, T. 159 N., R. 71 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure parting to moderate fine granular; slightly hard and friable; slightly sticky and slightly plastic; common very fine and fine roots; about 2 percent gravel; neutral; clear smooth boundary.

Bw1—7 to 19 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; neutral; clear wavy boundary.

Bw2—19 to 24 inches; dark brown (10YR 3/3) loam, brown (10YR 4/3) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; neutral; gradual wavy boundary.

Bw3—24 to 33 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; neutral; clear wavy boundary.

Bk—33 to 46 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; weak medium and coarse subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; about 5 percent gravel; few fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; clear wavy boundary.

C—46 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; slightly hard and friable; slightly sticky and slightly

plastic; about 8 percent gravel; few fine irregularly shaped soft masses of lime; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The C horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 or 6 dry), and chroma of 2 to 4. It is loam or sandy loam.

Eramosh Series

The Eramosh series consists of very deep, very poorly drained, moderately permeable soils on moraines and lake plains. These soils formed in organic material and alluvium. Slope is 0 to 1 percent.

Typical pedon of Eramosh peat, 450 feet south and 1,900 feet west of the northeast corner of sec. 24, T. 163 N., R. 71 W.

Oi—0 to 2 inches; black (10YR 2/1) peat, very dark grayish brown (10YR 3/2) dry; mostly undecomposed stems, leaves, and roots; neutral; abrupt smooth boundary.

Oe1—2 to 4 inches; black (10YR 2/1) mucky peat, very dark gray (10YR 3/1) dry; 50 percent fiber, 30 percent rubbed; weak medium granular structure; soft and very friable; nonsticky and nonplastic; many fine and very fine roots; neutral; clear smooth boundary.

Oe2—4 to 15 inches; very dark gray (10YR 3/1) mucky peat, dark gray (10YR 4/1) dry; 40 percent fiber, 25 percent rubbed; weak very coarse prismatic structure parting to weak medium granular; soft and very friable; nonsticky and nonplastic; common very fine roots; very slight effervescence; neutral; clear wavy boundary.

A—15 to 32 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak very coarse prismatic structure; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; about 20 percent snail shells; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg1—32 to 44 inches; very dark gray (5Y 3/1) silt loam, dark gray (5Y 4/1) dry; few medium prominent dark brown (10YR 3/3) mottles; massive; slightly hard and friable; slightly sticky and slightly plastic; very slight effervescence; slightly alkaline; gradual wavy boundary.

Cg2—44 to 60 inches; very dark gray (5Y 3/1) silt loam, dark gray (5Y 4/1) dry; few medium prominent dark yellowish brown (10YR 3/4) mottles; massive; slightly hard and friable; slightly sticky and slightly plastic; very slight effervescence; slightly alkaline.

The thickness of the histic epipedon ranges from 8 to 16 inches. The C horizon has hue of 2.5Y or 5Y, value of 3 to 5, and chroma of 1 or 2.

Esmond Series

The Esmond series consists of very deep, well drained, moderately permeable soils on till plains and moraines (fig. 11). These soils formed in glacial till. Slope ranges from 3 to 25 percent.

Typical pedon of Esmond loam, in an area of Heimdal-Esmond loams, 6 to 9 percent slopes, 2,450 feet south and 2,490 feet west of the northeast corner of sec. 31, T. 159 N., R. 71 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate medium and coarse subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; common very fine and fine roots; about 5 percent gravel; few fine irregularly shaped soft masses of lime; strong effervescence; slightly alkaline; abrupt smooth boundary.

Bk1—7 to 12 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; moderate coarse subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few very fine and fine roots; about 5 percent gravel; lime disseminated throughout; violent effervescence; moderately alkaline; clear wavy boundary.

Bk2—12 to 26 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; moderate medium and coarse subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few very fine and fine roots; about 5 percent gravel; common medium irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—26 to 47 inches; olive brown (2.5Y 4/4) sandy loam, light yellowish brown (2.5Y 6/4) dry; weak medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; about 8 percent gravel; few fine irregularly shaped soft masses of lime; slight effervescence; moderately alkaline; gradual wavy boundary.

C2—47 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; slightly hard and friable; slightly sticky and slightly plastic; about 8 percent gravel; slight effervescence; moderately alkaline.

The Ap horizon has value of 2 or 3 (3 to 5 dry). The Bk horizon has hue of 10YR or 2.5Y and value of 4 or 5 (5 to 7 dry). The C horizon has value of 4 or 5 (5 to 7 dry) and chroma of 2 to 4.

Gardena Series

The Gardena series consists of very deep, moderately well drained, moderately permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Gardena silt loam, 1,980 feet south and 75 feet east of the northwest corner of sec. 30, T. 159 N., R. 73 W.

Ap—0 to 9 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; soft and very friable; slightly sticky and slightly plastic; many fine roots; neutral; abrupt smooth boundary.

A—9 to 16 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate medium granular structure; soft and very friable; slightly sticky and slightly plastic; many fine and medium roots; neutral; clear smooth boundary.

Bw1—16 to 23 inches; very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; moderate medium subangular blocky structure; slightly hard and very friable; slightly sticky and slightly plastic; common fine roots; slightly alkaline; clear wavy boundary.

Bw2—23 to 29 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few fine and very fine roots; slightly alkaline; clear wavy boundary.

Bk—29 to 33 inches; light olive brown (2.5Y 5/4) silt loam, light brownish gray (2.5Y 6/2) dry; weak fine subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; many fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

C1—33 to 51 inches; olive brown (2.5Y 4/4) very fine sandy loam, light yellowish brown (2.5Y 6/4) dry; few medium prominent dark yellowish brown (10YR 4/6) mottles; massive; soft and very friable; nonsticky and nonplastic; common medium irregularly shaped soft masses of lime; slight effervescence; slightly alkaline; gradual wavy boundary.

C2—51 to 60 inches; olive brown (2.5Y 4/4) very fine sandy loam, light olive brown (2.5Y 5/4) dry; massive; soft and very friable; nonsticky and nonplastic; common medium irregularly shaped soft masses of lime; strong effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 16 to 40 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 2 to 4 (3 to 5 dry) and chroma of 1 to 3. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4.

Glyndon Series

The Glyndon series consists of very deep, somewhat poorly drained, moderately permeable, highly calcareous soils on lake plains. These soils formed in glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Glyndon silt loam, 1,520 feet east and 750 feet north of the southwest corner of sec. 4, T. 159 N., R. 72 W.

Ap—0 to 7 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; few very fine roots; slight effervescence; slightly alkaline; abrupt smooth boundary.

Bk1—7 to 22 inches; olive gray (5Y 5/2) silt loam, white (5Y 8/1) dry; common medium faint olive (5Y 5/3) mottles; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk2—22 to 29 inches; olive (5Y 5/3) silt loam, pale yellow (5Y 8/3) dry; few fine faint olive gray (5Y 5/2) mottles; slightly hard and friable; slightly sticky and slightly plastic; common fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

BCk—29 to 44 inches; olive (5Y 4/3) silt loam, pale yellow (5Y 7/3) dry; few fine faint olive gray (5Y 5/2) mottles; weak medium and coarse subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; clear smooth boundary.

C1—44 to 54 inches; olive (5Y 5/4) silt loam, pale yellow (5Y 7/4) dry; many fine distinct olive gray (5Y 5/2) and common fine distinct dark yellowish brown (10YR 4/6) mottles; massive; slightly hard and friable; slightly sticky and slightly plastic; moderately alkaline; gradual smooth boundary.

C2—54 to 60 inches; grayish brown (2.5Y 5/2) and olive brown (2.5Y 4/4) silt loam, light gray (5Y 7/2) and pale yellow (2.5Y 7/4) dry; common medium distinct dark yellowish brown (10YR 4/6) mottles; massive; slightly hard and friable; slightly sticky and slightly plastic; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 or 2. The Bk horizon has hue of 10YR to 5Y, value of 4 to 6 (5 to 8 dry), and chroma of 1 to 4. The C horizon has value of 4 to 6 (5 to 7 dry). It is loam or silt loam.

Great Bend Series

The Great Bend series consists of very deep, well drained, moderately slowly permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slope ranges from 0 to 3 percent.

Typical pedon of Great Bend silt loam, in an area of Great Bend-Overly silt loams, 0 to 3 percent slopes, 900 feet east and 1,600 feet north of the southwest corner of sec. 21, T. 159 N., R. 69 W.

Ap—0 to 6 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard and friable; slightly sticky and slightly plastic; common fine roots; slightly alkaline; abrupt smooth boundary.

A—6 to 8 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; hard and friable; slightly sticky and slightly plastic; common fine roots; slightly alkaline; clear smooth boundary.

Bw—8 to 13 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark brown (10YR 4/3) dry; moderate medium prismatic structure parting to weak medium subangular blocky; hard and firm; sticky and plastic; few fine roots; slightly alkaline; clear smooth boundary.

Bk1—13 to 19 inches; yellowish brown (10YR 5/4) silt loam, light yellowish brown (10YR 6/4) dry; weak medium prismatic structure parting to weak medium subangular blocky; hard and friable; slightly sticky and slightly plastic; few fine roots; few fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear smooth boundary.

Bk2—19 to 26 inches; yellowish brown (10YR 5/4) silt loam, very pale brown (10YR 7/4) dry; weak medium prismatic structure; slightly hard and friable; slightly sticky and slightly plastic; few fine roots; common medium irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear smooth boundary.

C1—26 to 42 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; massive; slightly hard and friable; slightly sticky and slightly plastic; violent effervescence; moderately alkaline; clear smooth boundary.

C2—42 to 60 inches; olive brown (2.5Y 4/4) silty clay loam, pale yellow (2.5Y 7/4) dry; massive; hard and firm; sticky and plastic; violent effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has value of 2 or 3 (3 to 5 dry). The Bw horizon has value of 3 to 5 (4 to 6 dry) and chroma of 2 to 4. It is silt loam or silty clay loam. The C horizon has value of 4 to 6 (6 to 8 dry) and chroma of 2 to 4.

Hamar Series

The Hamar series consists of very deep, somewhat poorly drained, rapidly permeable soils on lake plains and outwash plains. These soils formed in glaciolacustrine and glaciofluvial deposits and in eolian material. Slope ranges from 0 to 3 percent.

Typical pedon of Hamar loamy fine sand, in an area of Hecla-Hamar loamy fine sands, 0 to 3 percent slopes, 1,100 feet south and 2,370 feet east of the northwest corner of sec. 10, T. 159 N., R. 71 W.

A1—0 to 5 inches; black (10YR 2/1) loamy fine sand, very dark gray (10YR 3/1) dry; weak fine granular structure; soft and very friable; nonsticky and nonplastic; many very fine and fine and few medium roots; slightly acid; clear smooth boundary.

A2—5 to 12 inches; black (10YR 2/1) loamy fine sand, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; soft and very friable; nonsticky and nonplastic; many very fine and fine and few medium roots; slightly acid; clear smooth boundary.

AC—12 to 17 inches; very dark gray (10YR 3/1) fine sand, dark gray (10YR 4/1) dry; common fine distinct dark brown (10YR 3/3) mottles; weak medium subangular blocky structure; loose; nonsticky and nonplastic; common very fine and fine and few medium roots; neutral; clear smooth boundary.

C1—17 to 49 inches; dark gray (5Y 4/1) fine sand, gray (5Y 6/1) dry; moderate medium distinct very dark grayish brown (2.5Y 3/2) and dark grayish brown (2.5Y 4/2) mottles; single grain; loose; nonsticky and nonplastic; few very fine, fine, and medium roots; slightly alkaline; clear wavy boundary.

C2—49 to 60 inches; olive gray (5Y 4/2) fine sand, light gray (5Y 7/2) dry; many medium distinct dark grayish brown (2.5Y 4/2) mottles; single grain; loose; nonsticky and nonplastic; strong effervescence; slightly alkaline.

The A horizon has value of 2 or 3 (3 or 4 dry). The AC horizon has value of 2 or 3 (3 to 5 dry) and chroma

of 1 or 2. The C horizon has hue of 2.5Y or 5Y, value of 3 to 5 (5 to 7 dry), and chroma of 1 to 4. It is loamy fine sand, loamy sand, or fine sand.

Hamerly Series

The Hamerly series consists of very deep, somewhat poorly drained, moderately slowly permeable, highly calcareous soils on till plains (fig. 12). These soils formed in glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Hamerly loam, in an area of Hamerly-Tonka-Parnell complex, 0 to 3 percent slopes, 2,100 feet west and 1,970 feet north of the southeast corner of sec. 33, T. 160 N., R. 69 W.

Ap—0 to 4 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; about 3 percent gravel; slight effervescence; slightly alkaline; abrupt smooth boundary.

A—4 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; about 3 percent gravel; slight effervescence; slightly alkaline; gradual wavy boundary.

Bk1—7 to 15 inches; light brownish gray (2.5Y 6/2) loam, light gray (2.5Y 7/2)) dry; few fine prominent yellowish brown (10YR 5/4) mottles; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard and firm; slightly sticky and plastic; few very fine roots; about 5 percent gravel; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk2—15 to 29 inches; light yellowish brown (2.5Y 6/4) loam, pale yellow (2.5Y 7/4) dry; common medium distinct grayish brown (2.5Y 5/2) and common fine distinct dark yellowish brown (10YR 4/4) mottles; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard and firm; slightly sticky and plastic; few very fine roots; about 5 percent gravel; lime disseminated throughout; violent effervescence; moderately alkaline; clear wavy boundary.

BCk—29 to 34 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; common medium distinct grayish brown (2.5Y 5/2) mottles; massive; hard and firm; slightly sticky and plastic; about 6 percent gravel; lime disseminated throughout; strong effervescence; moderately alkaline; clear wavy boundary.

C—34 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; common large prominent gray (5Y 5/1) mottles; massive; hard and firm; slightly sticky and plastic; about 6 percent gravel; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. In some pedons the soils are saline.

The A horizon has value of 2 or 3 (3 to 5 dry). The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 to 4. The C horizon has hue of 10YR to 5Y, value of 4 to 6 (5 to 8 dry), and chroma of 1 to 4.

Harriet Series

The Harriet series consists of very deep, poorly drained, very slowly permeable, sodic, saline soils on flood plains. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Harriet silt loam, 750 feet south and 1,160 feet east of the northwest corner of sec. 29, T. 160 N., R. 73 W.

E—0 to 2 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; moderate very thin platy structure; soft and very friable; slightly sticky and slightly plastic; many fine and very fine roots; neutral; abrupt smooth boundary.

Btn—2 to 9 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; strong coarse columnar structure parting to strong coarse subangular blocky; very hard and very firm; sticky and plastic; common very fine and fine roots on faces of peds; many distinct clay films on faces of peds; gray (10YR 6/1) silt coatings; moderately alkaline; gradual wavy boundary.

Btnzg—9 to 24 inches; black (5Y 2/1) silty clay loam, dark gray (5Y 4/1) dry; strong coarse subangular blocky structure; very hard and very firm; sticky and plastic; few very fine and fine roots; common faint clay films on faces of peds; few flecks and threads of salts; few fine irregularly shaped soft masses of lime; moderately alkaline; gradual irregular boundary.

Bkg—24 to 36 inches; olive gray (5Y 4/2) silty clay loam, light olive gray (5Y 6/2) dry; many fine faint olive (5Y 4/3) mottles; strong coarse subangular blocky structure; hard and firm; sticky and plastic; few very fine and fine roots; few fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

Bkyg—36 to 49 inches; olive gray (5Y 4/2) silty clay loam, olive gray (5Y 5/2) dry; common fine faint olive (5Y 5/3) mottles; weak coarse subangular blocky structure; hard and firm; sticky and plastic; few medium masses of gypsum; common fine

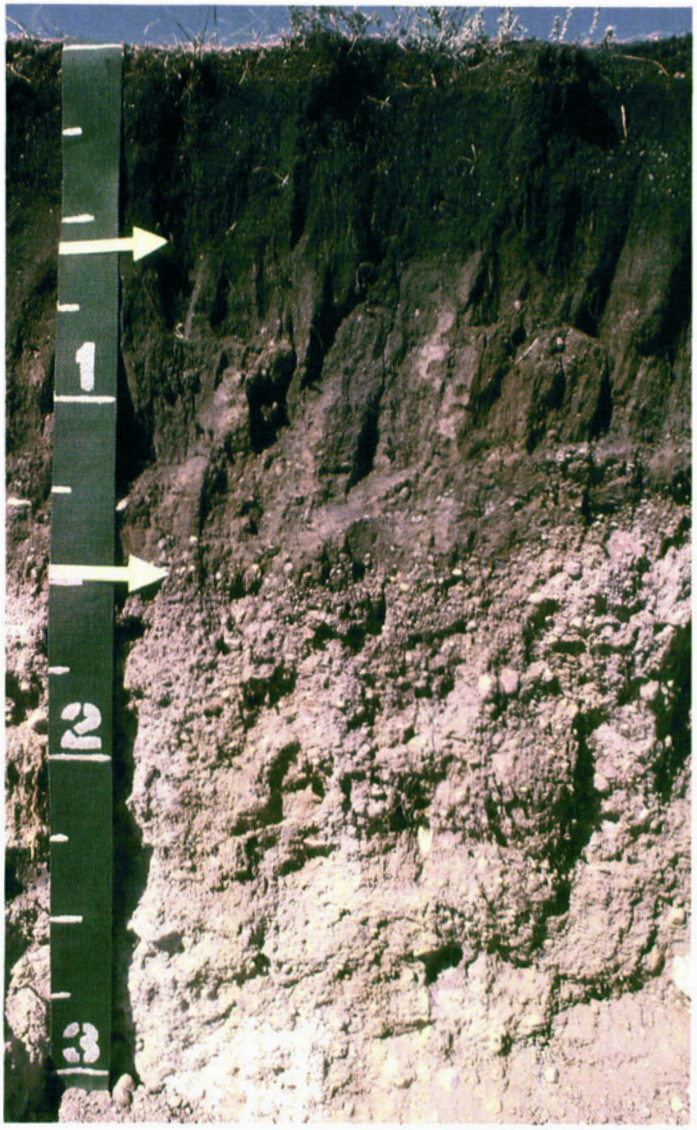

Figure 10.—Profile of an Arvilla sandy loam. This soil has a dark surface layer and subsoil and a light colored, gravelly substratum. Depth is marked in feet.

Figure 11.—Profile of an Esmond loam. This soil has a dark surface layer and a light colored subsoil. Depth is marked in feet.

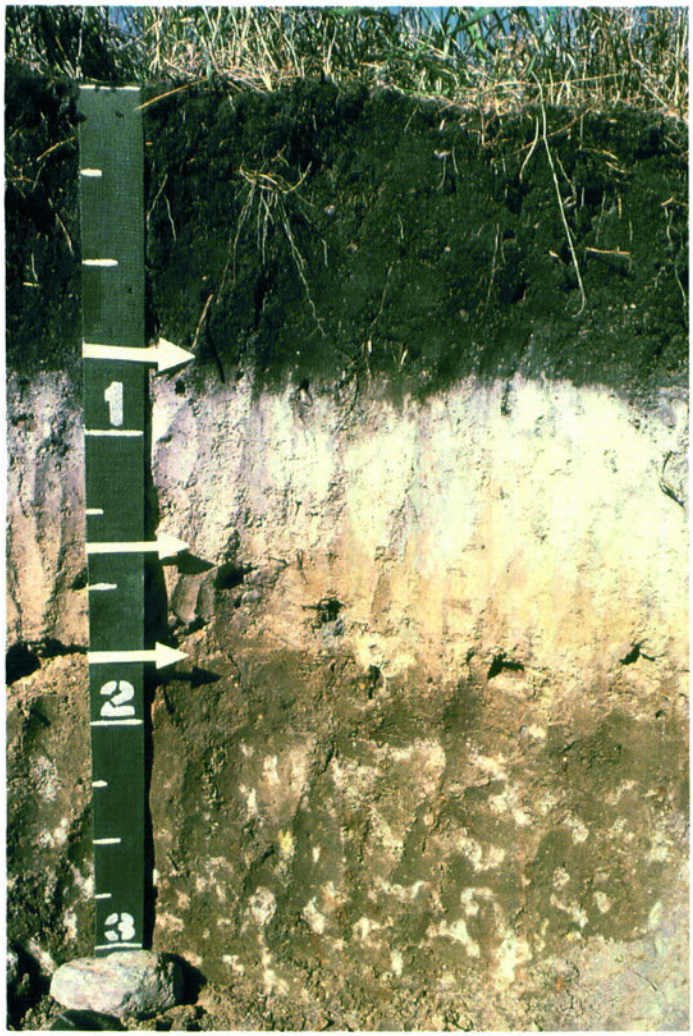

Figure 12.—Profile of a Hamerly loam. The subsoil is light colored and is enriched with lime. Depth is marked in feet.

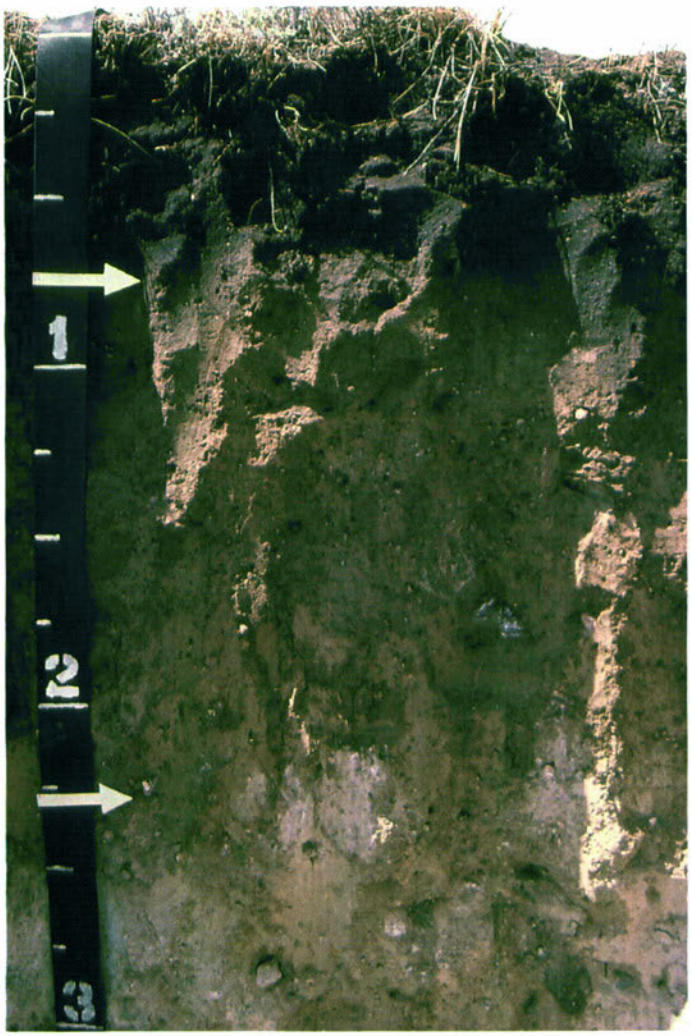

Figure 13.—Profile of a Heimdal loam. This soil has a dark surface layer and a lighter colored subsoil. Depth is marked in feet.

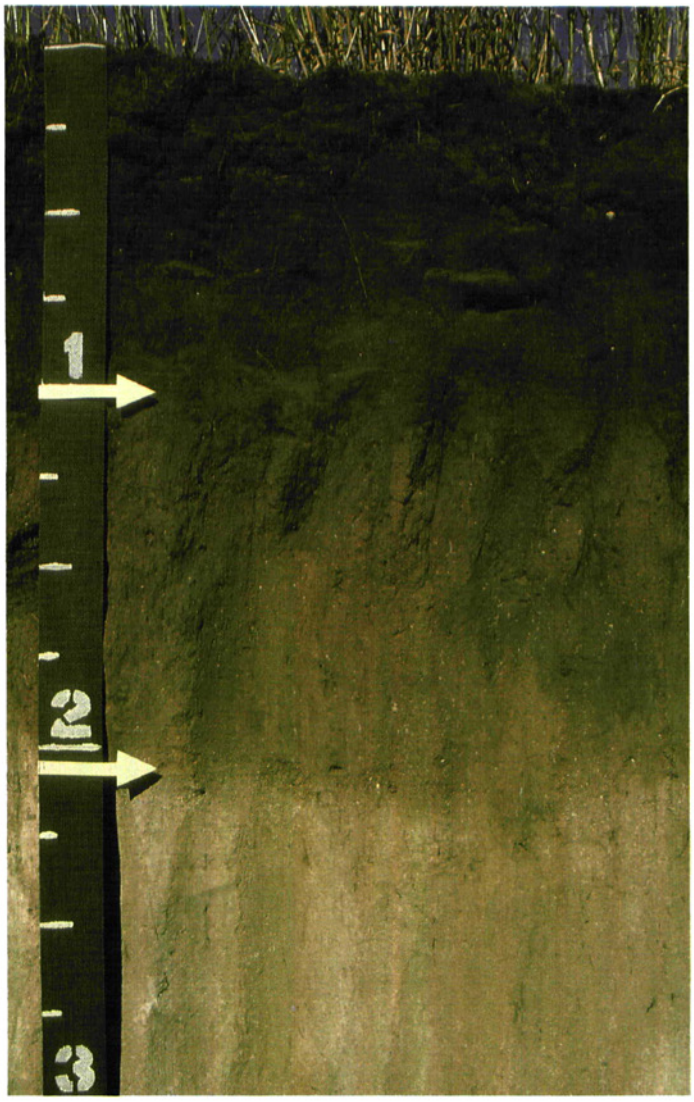

Figure 14.—Profile of a Maddock loamy fine sand. This soil has a dark surface layer and a lighter colored subsoil. Depth is marked in feet.

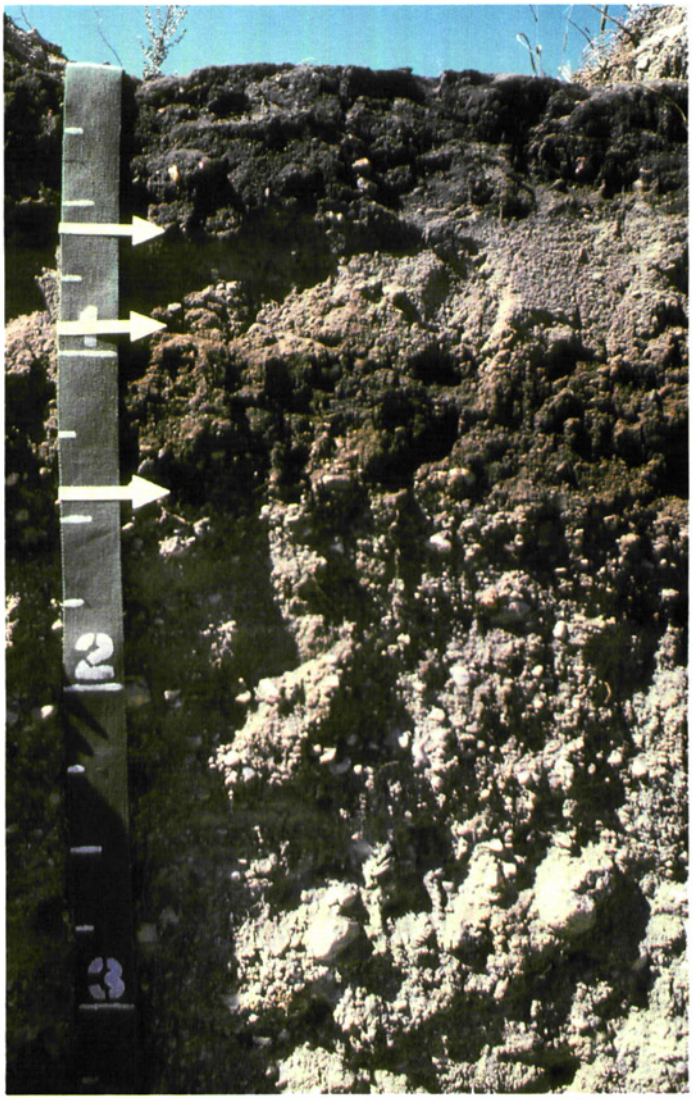

Figure 15.—Profile of a Metigoshe sandy loam. This soil has a gravelly substratum. Depth is marked in feet.

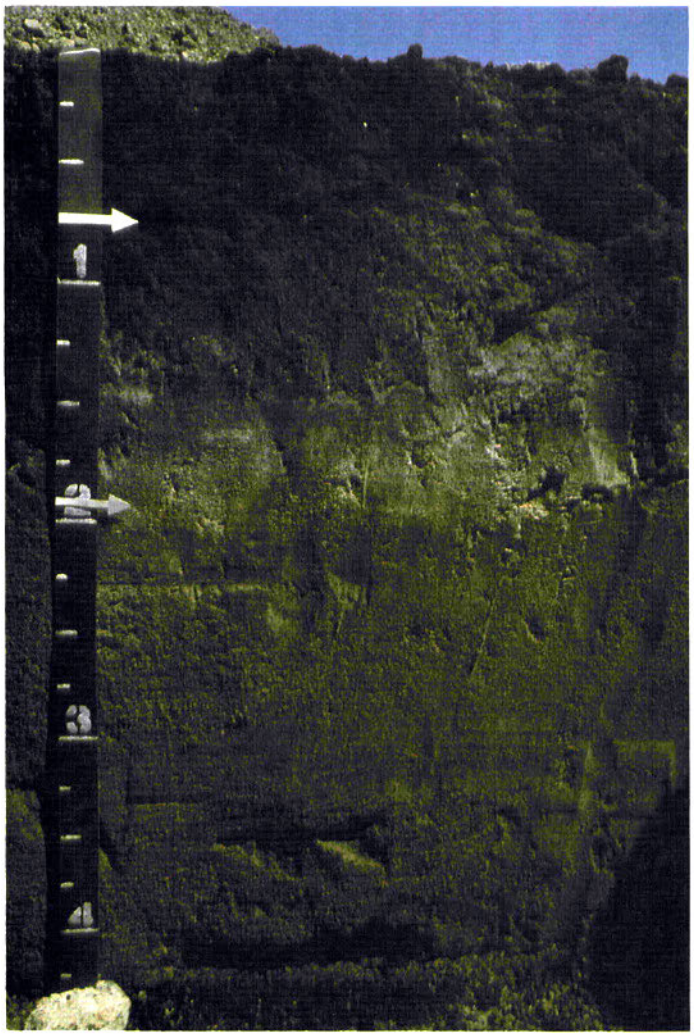

Figure 16.—Profile of a Ulen fine sandy loam. The subsoil is light colored and contains lime, and the substratum is sandy. Depth is marked in feet.

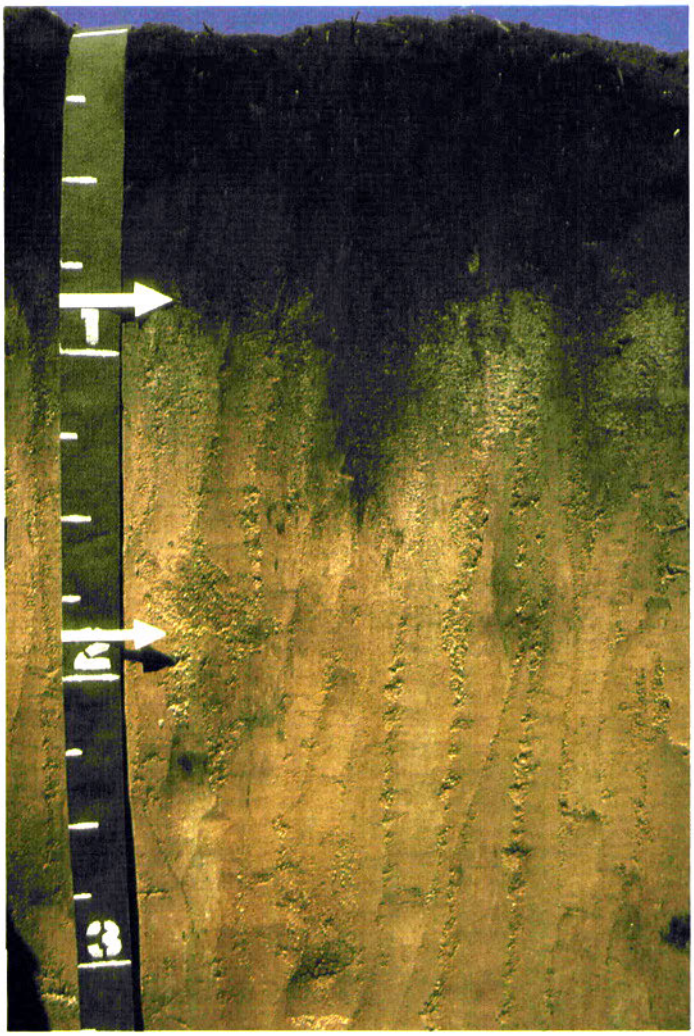

Figure 17.—Profile of a Wyndmere fine sandy loam. The subsoil is light colored and is enriched with lime. Depth is marked in feet.

irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; clear smooth boundary.

Cg—49 to 60 inches; olive gray (5Y 4/2) silty clay loam, light olive gray (5Y 6/2) dry; massive; hard and firm; sticky and plastic; moderately alkaline.

The E horizon has hue of 10YR or 2.5Y and value of 2 to 4 (4 to 6 dry). The Btn horizon has value of 2 to 4 (4 or 5 dry) and chroma of 1 or 2. It is clay loam, silty clay loam, or silty clay. The C horizon has hue of 2.5Y or 5Y, value of 3 to 5 (5 to 7 dry), and chroma of 1 to 3.

Hecla Series

The Hecla series consists of very deep, moderately well drained, rapidly permeable soils on lake plains. These soils formed in eolian material and glaciolacustrine deposits. Slope ranges from 0 to 3 percent.

Typical pedon of Hecla loamy fine sand, 0 to 3 percent slopes, 2,240 feet east and 2,280 feet south of the northwest corner of sec. 10, T. 159 N., R. 71 W.

Ap—0 to 6 inches; black (10YR 2/1) loamy fine sand, very dark gray (10YR 3/1) dry; weak medium and fine granular structure; soft and very friable; nonsticky and nonplastic; many very fine and fine roots; slightly alkaline; abrupt smooth boundary.

A—6 to 20 inches; black (10YR 2/1) loamy fine sand, very dark gray (10YR 3/1) dry; weak medium and coarse subangular blocky structure; soft and very friable; nonsticky and nonplastic; common very fine and fine roots; neutral; gradual wavy boundary.

AC—20 to 26 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; weak medium and coarse subangular blocky structure; soft and very friable; nonsticky and nonplastic; few very fine and fine roots; slightly acid; gradual wavy boundary.

C1—26 to 34 inches; dark brown (10YR 4/3) fine sand, pale brown (10YR 6/3) dry; few fine distinct dark gray (10YR 4/1) and few fine faint very dark grayish brown (10YR 3/2) mottles; weak medium and coarse subangular blocky structure; loose; nonsticky and nonplastic; few very fine and fine roots; slightly acid; clear wavy boundary.

C2—34 to 45 inches; brown (10YR 5/3) fine sand, pale brown (10YR 6/3) dry; few fine faint grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; loose; nonsticky and nonplastic; few very fine and fine roots; neutral; clear smooth boundary.

C3—45 to 60 inches; grayish brown (2.5Y 5/2) loamy fine sand, light brownish gray (2.5Y 6/2) dry; few fine distinct gray (10YR 5/1) mottles; massive; loose; nonsticky and nonplastic; strong effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 10 to 20 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The AC horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 or 2. It is loamy fine sand, loamy sand, or fine sand. The C horizon has hue of 10YR to 5Y and value of 3 to 5 (4 to 6 dry). It is loamy fine sand, loamy sand, or fine sand.

Heimdal Series

The Heimdal series consists of very deep, well drained, moderately permeable soils on till plains and moraines (fig. 13). These soils formed in glacial till. Slope ranges from 0 to 25 percent.

Typical pedon of Heimdal loam, in an area of Heimdal-Emrick-Esmond loams, 3 to 6 percent slopes, 1,545 feet south and 550 feet west of the northeast corner of sec. 34, T. 159 N., R. 71 W.

Ap—0 to 4 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate fine granular structure; soft and very friable; slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; neutral; abrupt smooth boundary.

A—4 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate coarse subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; neutral; clear smooth boundary.

Bw1—8 to 11 inches; dark brown (10YR 3/3) loam, brown (10YR 4/3) dry; moderate coarse prismatic structure parting to moderate coarse subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; neutral; gradual wavy boundary.

Bw2—11 to 17 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; moderate coarse prismatic structure parting to moderate coarse subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; slightly alkaline; clear wavy boundary.

Bk—17 to 32 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; weak coarse subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; about 5 percent gravel; common fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear smooth boundary.

C—32 to 60 inches; dark grayish brown (2.5Y 4/2)

loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard and friable; slightly sticky and slightly plastic; about 2 percent gravel; strong effervescence; moderately alkaline.

The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has chroma of 2 to 4. The Bk horizon has value of 4 or 5 (5 or 6 dry) and chroma of 2 to 4. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 or 6 dry), and chroma of 2 to 4.

Kelvin Series

The Kelvin series consists of very deep, well drained, moderately slowly permeable soils on till plains and moraines. These soils formed in glacial till. Slope ranges from 3 to 25 percent.

Typical pedon of Kelvin loam, 9 to 25 percent slopes, 1,400 feet south and 2,200 feet east of the northwest corner of sec. 35, T. 163 N., R. 72 W.

Oi—2 inches to 0; black (N 2/0), undecomposed leaves and twigs; neutral; clear smooth boundary.

E—0 to 4 inches; dark grayish brown (10YR 4/2) and very dark grayish brown (10YR 3/2) loam, light brownish gray (10YR 6/2) and grayish brown (10YR 5/2) dry; weak medium platy structure parting to moderate medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; common fine and very fine and few medium and coarse roots; about 2 percent gravel; neutral; clear smooth boundary.

Bt1—4 to 13 inches; dark grayish brown (10YR 4/2) clay, light brownish gray (10YR 6/2) dry; moderate medium prismatic structure parting to strong medium and fine angular blocky; very hard and very firm; very sticky and very plastic; few very fine, fine, medium, and coarse roots; continuous prominent clay films on faces of peds; about 3 percent gravel; neutral; gradual wavy boundary.

Bt2—13 to 23 inches; dark grayish brown (10YR 4/2) clay, light brownish gray (10YR 6/2) dry; moderate coarse prismatic structure parting to strong medium and fine angular blocky; very hard and very firm; very sticky and very plastic; few very fine, fine, medium, and coarse roots; continuous prominent clay films on faces of peds; about 6 percent gravel; strongly acid; gradual wavy boundary.

Bk—23 to 39 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; moderate medium subangular blocky structure; hard and firm; sticky and plastic; few medium and coarse roots; about 6 percent gravel; many fine irregularly shaped soft masses of lime; strong effervescence; slightly alkaline; gradual wavy boundary.

C—39 to 60 inches; dark brown (10YR 4/3) clay loam, pale brown (10YR 6/3) dry; massive; hard and firm; sticky and plastic; about 6 percent gravel; common fine and medium irregularly shaped soft masses of lime; strong effervescence; moderately alkaline.

Some pedons have an A horizon, which is 1 to 3 inches thick. The E horizon has value of 5 to 7 dry and chroma of 1 or 2. The Bt horizon has value of 3 to 5 (5 or 6 dry) and chroma of 2 to 4. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 or 6 dry), and chroma of 2 to 4. It is loam or clay loam.

Lanona Series

The Lanona series consists of very deep, well drained soils on till plains and lake plains. These soils formed in glacial till and glaciolacustrine deposits. Permeability is moderately rapid in the upper part of the profile and moderately slow in the lower part. Slope ranges from 1 to 6 percent.

Typical pedon of Lanona fine sandy loam, in an area of Lanona-Swenoda fine sandy loams, 1 to 6 percent slopes, 1,900 feet north and 750 feet east of the southwest corner of sec. 24, T. 159 N., R. 70 W.

Ap—0 to 9 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak coarse subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; few fine and very fine roots; neutral; clear smooth boundary.

Bw—9 to 14 inches; dark brown (10YR 3/3) fine sandy loam, brown (10YR 5/3) dry; weak coarse prismatic structure; soft and very friable; slightly sticky and slightly plastic; few very fine roots; slightly alkaline; abrupt smooth boundary.

Bk1—14 to 20 inches; dark brown (10YR 4/3) fine sandy loam, brown (10YR 5/3) dry; weak coarse prismatic structure; soft and very friable; slightly sticky and slightly plastic; common fine irregularly shaped soft masses of lime; strong effervescence; slightly alkaline; clear smooth boundary.

Bk2—20 to 29 inches; light brownish gray (2.5Y 6/2) fine sandy loam, light gray (2.5Y 7/2) dry; massive; soft and very friable; slightly sticky and slightly plastic; common fine irregularly shaped soft masses of lime; strong effervescence; slightly alkaline; clear wavy boundary.

2C—29 to 60 inches; olive brown (2.5Y 4/4) clay loam, light yellowish brown (2.5Y 6/4) dry; massive; hard and firm; sticky and plastic; about 2 percent gravel; common fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline.

Depth to the 2C horizon ranges from 20 to 40 inches.

The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 2 to 5 (4 to 6 dry) and chroma of 1 to 4. Some pedons have a 2BK or 2BC horizon, which is 5 to 10 inches thick. The 2C horizon has value of 4 to 6 (6 or 7 dry) and chroma of 2 to 4. It is loam, silt loam, clay loam, or silty clay loam.

Larson Series

The Larson series consists of very deep, moderately well drained, slowly permeable, sodic soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Larson loam, in an area of Cathay-Larson loams, 0 to 6 percent slopes, 1,650 feet south and 2,150 feet west of the northeast corner of sec. 32, T. 159 N., R. 71 W.

A—0 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium and fine granular structure; slightly hard and friable; slightly sticky and slightly plastic; many fine and very fine roots; about 2 percent gravel; neutral; gradual smooth boundary.

E—9 to 12 inches; dark grayish brown (10YR 4/2) fine sandy loam, grayish brown (10YR 5/2) dry; moderate medium and thin platy structure; soft and very friable; slightly sticky and slightly plastic; many fine and very fine roots; about 2 percent gravel; neutral; abrupt smooth boundary.

Btn—12 to 18 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; strong coarse columnar structure parting to strong medium and coarse angular blocky; extremely hard and very firm; sticky and plastic; common very fine roots compressed on faces of peds; continuous distinct clay films on faces of peds; about 2 percent gravel; slightly alkaline; clear wavy boundary.

Btkn—18 to 23 inches; dark grayish brown (2.5Y 4/2) loam, grayish brown (2.5Y 5/2) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; hard and firm; sticky and plastic; few very fine roots; few faint clay films lining pores; about 5 percent gravel; many medium irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

Bky—23 to 30 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct grayish brown (2.5Y 5/2) mottles; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; about 6 percent gravel; few fine masses of gypsum crystals; common fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C1—30 to 52 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; common fine faint olive brown (2.5Y 4/4) and common fine prominent gray (10YR 5/1) mottles; massive; slightly hard and friable; slightly sticky and slightly plastic; about 8 percent gravel; slight effervescence; moderately alkaline; clear wavy boundary.

C2—52 to 60 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; common medium distinct olive brown (2.5Y 4/4) mottles; massive; slightly hard and friable; slightly sticky and slightly plastic; about 8 percent gravel; slight effervescence; moderately alkaline.

The A horizon has value of 2 or 3 (3 to 5 dry). The E horizon has value of 3 to 5 (5 to 7 dry) and chroma of 1 or 2. It is fine sandy loam or loam. The Btn horizon has value of 2 to 4 (4 to 6 dry) and chroma of 1 to 3. It is loam or clay loam. The C horizon has hue of 10YR or 2.5Y and value of 4 to 6 (5 to 7 dry).

Letcher Series

The Letcher series consists of very deep, moderately well drained, sodic soils on outwash plains. These soils formed in glaciofluvial deposits. Permeability is slow in the upper part of the profile and moderate in the lower part. Slope ranges from 0 to 6 percent.

Typical pedon of Letcher fine sandy loam, 0 to 6 percent slopes, 1,860 feet north and 1,745 feet east of the southwest corner of sec. 13, T. 159 N., R. 72 W.

Ap—0 to 4 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak medium and fine granular structure; soft and very friable; slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; slightly acid; clear smooth boundary.

A—4 to 8 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; moderate medium and coarse subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; slightly acid; clear smooth boundary.

E—8 to 13 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak medium and coarse subangular blocky structure; soft and very friable; nonsticky and nonplastic; common very fine roots; about 1 percent gravel; neutral; abrupt smooth boundary.

Btn1—13 to 18 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; strong coarse columnar structure; very hard and firm; slightly sticky and plastic; common very fine roots compressed on faces of peds; continuous distinct clay bridges between mineral grains; about

1 percent gravel; slightly alkaline; clear wavy boundary.

Btn2—18 to 24 inches; dark brown (10YR 4/3) sandy loam, brown (10YR 5/3) dry; strong coarse prismatic structure; very hard and firm; slightly sticky and plastic; few very fine roots; many distinct clay bridges between mineral grains; about 2 percent gravel; moderately alkaline; gradual wavy boundary.

2Bk1—24 to 29 inches; yellowish brown (10YR 5/4) loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; hard and firm; slightly sticky and plastic; few very fine roots; about 5 percent gravel; lime disseminated throughout; strong effervescence; strongly alkaline; gradual wavy boundary.

2Bk2—29 to 40 inches; brown (10YR 5/3) loam, very pale brown (10YR 7/3) dry; weak medium and coarse subangular blocky structure; hard and firm; slightly sticky and plastic; about 5 percent gravel; many fine irregularly shaped soft masses of lime; strong effervescence; strongly alkaline; clear wavy boundary.

2C—40 to 60 inches; yellowish brown (10YR 5/4) loam, very pale brown (10YR 7/4) dry; common fine prominent grayish brown (2.5Y 5/2) mottles; massive; hard and firm; slightly sticky and plastic; about 7 percent gravel; strong effervescence; moderately alkaline.

The A horizon has value of 2 or 3 (4 or 5 dry). The E horizon has value of 3 to 5 (5 to 7 dry) and chroma of 1 or 2. It is loamy fine sand, fine sandy loam, or sandy loam. The Btn horizon has hue of 10YR or 2.5Y. It is fine sandy loam or sandy loam. The 2Bk horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 2 to 4. It is fine sandy loam, sandy loam, loamy sand, or loam. The 2C horizon has hue of 10YR to 5Y, value of 3 to 5 (5 to 7 dry), and chroma of 1 to 4. It is fine sandy loam, sandy loam, loamy fine sand, or loam.

Lohnes Series

The Lohnes series consists of very deep, well drained, rapidly permeable soils on outwash plains. These soils formed in glaciofluvial deposits. Slope ranges from 0 to 25 percent.

Typical pedon of Lohnes loamy sand, 0 to 6 percent slopes, 1,170 feet south and 1,220 feet west of the northeast corner of sec. 12, T. 160 N., R. 72 W.

Ap—0 to 7 inches; black (10YR 2/1) loamy sand, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to weak fine granular; soft and very friable; slightly sticky and slightly plastic; many very fine and few fine roots; slightly alkaline; clear smooth boundary.

A—7 to 14 inches; very dark grayish brown (10YR 3/2) loamy sand, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; soft and very friable; nonsticky and nonplastic; few very fine roots; slightly alkaline; gradual wavy boundary.

Bw—14 to 20 inches; dark brown (10YR 4/3) loamy sand, brown (10YR 5/3) dry; weak medium subangular blocky structure; loose; nonsticky and nonplastic; slightly alkaline; clear wavy boundary.

C1—20 to 31 inches; dark brown (10YR 4/3) coarse sand, pale brown (10YR 6/3) dry; single grain; loose; nonsticky and nonplastic; few very fine roots; about 4 percent gravel; violent effervescence; slightly alkaline; gradual wavy boundary.

C2—31 to 42 inches; dark brown (10YR 4/3) coarse sand, pale brown (10YR 6/3) dry; single grain; loose; nonsticky and nonplastic; about 6 percent gravel; slight effervescence; slightly alkaline; clear wavy boundary.

C3—42 to 47 inches; dark brown (10YR 4/3) coarse sand, pale brown (10YR 6/3) dry; single grain; loose; nonsticky and nonplastic; about 10 percent gravel; violent effervescence; slightly alkaline; clear wavy boundary.

C4—47 to 60 inches; dark brown (10YR 4/3) coarse sand, pale brown (10YR 6/3) dry; single grain; loose; nonsticky and nonplastic; about 6 percent gravel; strong effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 10 to 20 inches. The A horizon has value of 3 to 5 dry. The Bw horizon has value of 3 or 4 (4 or 5 dry) and chroma of 2 to 4. It is loamy sand, loamy coarse sand, sand, or coarse sand. The C horizon has hue of 10YR or 2.5Y, value of 3 to 6 (4 to 7 dry), and chroma of 2 to 4. It is coarse sand or sand.

Maddock Series

The Maddock series consists of very deep, well drained, rapidly permeable soils on lake plains and moraines (fig. 14). These soils formed in sandy eolian material and glaciolacustrine deposits. Slope ranges from 1 to 25 percent.

Typical pedon of Maddock loamy fine sand, in an area of Maddock-Hecla loamy fine sands, 1 to 6 percent slopes, 1,635 feet north and 55 feet east of the southwest corner of sec. 31, T. 159 N., R. 71 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine granular structure; soft and very friable; nonsticky and

nonplastic; common very fine roots; neutral; clear smooth boundary.

Bw—6 to 13 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark brown (10YR 4/3) dry; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; soft and very friable; nonsticky and nonplastic; few very fine roots; neutral; gradual wavy boundary.

BC—13 to 33 inches; dark brown (10YR 4/3) fine sand, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; soft and very friable; nonsticky and nonplastic; few very fine roots; neutral; gradual wavy boundary.

C—33 to 60 inches; brown (10YR 5/3) fine sand, pale brown (10YR 6/3) dry; single grain; loose; nonsticky and nonplastic; slightly alkaline.

The thickness of the mollic epipedon ranges from 10 to 16 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 2 to 4 (4 to 6 dry) and chroma of 2 to 4. It is loamy fine sand or fine sand. The C horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. It is fine sand or sand.

Marysland Series

The Marysland series consists of very deep, poorly drained, highly calcareous soils on outwash plains. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slope is 0 to 1 percent.

Typical pedon of Marysland silt loam, 1,365 feet west and 2,535 feet north of the southeast corner of sec. 2, T. 160 N., R. 70 W.

A—0 to 6 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate medium and fine granular structure; soft and friable; slightly sticky and slightly plastic; many very fine and fine roots; violent effervescence; slightly alkaline; gradual smooth boundary.

ABkg—6 to 18 inches; very dark gray (5Y 3/1) silt loam, gray (5Y 5/1) dry; weak coarse prismatic structure parting to moderate medium and coarse subangular blocky; slightly hard and friable; slightly sticky and plastic; common very fine roots; about 2 percent gravel; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Bkg1—18 to 25 inches; gray (5Y 5/1) and light olive gray (5Y 6/2) loam, light gray (5Y 6/1) and white (5Y 8/1) dry; few medium faint pale olive (5Y 6/3) mottles; weak coarse prismatic structure parting to moderate medium and coarse subangular blocky; hard and friable; slightly sticky and plastic; few very fine roots; about 5 percent gravel; lime disseminated throughout; violent effervescence; gradual wavy boundary.

Bkg2—25 to 32 inches; olive gray (5Y 5/2) loam, light gray (5Y 7/2) dry; few fine prominent yellowish brown (10YR 5/4) mottles; moderate medium and coarse subangular blocky structure; slightly hard and friable; slightly sticky and plastic; few very fine roots; about 14 percent gravel; common medium irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; clear wavy boundary.

2Cg1—32 to 38 inches; olive gray (5Y 5/2) gravelly loamy coarse sand, light gray (5Y 7/2) dry; many fine prominent olive brown (2.5Y 4/4) mottles; single grain; loose; nonsticky and nonplastic; about 20 percent gravel; slight effervescence; moderately alkaline; clear smooth boundary.

2Cg2—38 to 46 inches; olive brown (2.5Y 4/4) coarse sand, light yellowish brown (2.5Y 6/4) dry; few fine distinct grayish brown (2.5Y 5/2) mottles; single grain; loose; nonsticky and nonplastic; about 10 percent gravel; slight effervescence; moderately alkaline; clear wavy boundary.

2Cg3—46 to 54 inches; dark grayish brown (2.5Y 4/2) sand, light brownish gray (2.5Y 6/2) dry; common medium distinct olive brown (2.5Y 4/4) mottles; single grain; loose; nonsticky and nonplastic; about 10 percent gravel; slight effervescence; moderately alkaline; clear smooth boundary.

2Cg4—54 to 60 inches; dark grayish brown (2.5Y 4/2) gravelly coarse sand, light brownish gray (2.5Y 6/2) dry; few medium distinct olive brown (2.5Y 4/4) mottles; single grain; loose; nonsticky and nonplastic; about 25 percent gravel; slight effervescence; moderately alkaline.

Depth to the 2Cg horizon ranges from 20 to 40 inches. The A horizon has hue of 10YR to 5Y and value of 2 or 3 (2 to 5 dry). The Bk horizon has hue of 10YR to 5Y or is neutral in hue. It has value of 3 to 6 (4 to 8 dry) and chroma of 0 to 2. The 2Cg horizon has value of 3 to 5 (4 to 7 dry) and chroma of 1 to 4.

Metigoshe Series

The Metigoshe series consists of very deep, well drained soils on outwash plains (fig. 15). These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and very rapid in the lower part. Slope ranges from 3 to 25 percent.

Typical pedon of Metigoshe sandy loam, 9 to 25 percent slopes, 2,100 feet south and 2,400 feet west of the northeast corner of sec. 33, T. 163 N., R. 72 W.

Oi—1 inch to 0; black (10YR 2/1), undecomposed leaves and twigs; neutral; abrupt smooth boundary.

A—0 to 5 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to weak medium granular; soft and friable; nonsticky and slightly plastic; common fine and very fine and few medium and coarse roots; neutral; clear smooth boundary.

E—5 to 8 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; soft and very friable; nonsticky and nonplastic; common fine and very fine and few medium and coarse roots; neutral; clear wavy boundary.

Bt—8 to 15 inches; dark brown (10YR 4/3) sandy loam, brown (10YR 5/3) dry; moderate medium and coarse subangular blocky structure; hard and firm; sticky and plastic; common fine and very fine and few medium and coarse roots; common distinct clay bridges between mineral grains; neutral; gradual wavy boundary.

2C1—15 to 19 inches; dark brown (10YR 4/3) gravelly sand, brown (10YR 5/3) dry; single grain; loose; nonsticky and nonplastic; few very fine, fine, medium, and coarse roots; about 25 percent gravel; slight effervescence; neutral; gradual wavy boundary.

2C2—19 to 60 inches; dark grayish brown (10YR 4/2) gravelly sand, grayish brown (10YR 5/2) dry; single grain; loose; nonsticky and nonplastic; about 30 percent gravel; strong effervescence; neutral.

The thickness of the mollic epipedon ranges from 7 to 11 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The E horizon has value of 3 or 4 (5 to 7 dry) and chroma of 2 to 4. It is loamy sand or loamy coarse sand. The Bt horizon has value of 3 or 4 (4 to 6 dry) and chroma of 2 to 4. It is sandy loam or coarse sandy loam. The 2C horizon has value of 3 to 5 (5 to 7 dry) and chroma of 2 to 4. It is gravelly sand or gravelly coarse sand.

Miranda Series

The Miranda series consists of very deep, somewhat poorly drained, very slowly permeable, sodic, saline soils on till plains. These soils formed in glacial till. Slope is 0 to 1 percent.

Typical pedon of Miranda loam, in an area of Miranda-Cavour loams, 1,500 feet north and 2,560 feet west of the southeast corner of sec. 29, T. 161 N., R. 72 W.

E—0 to 2 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak fine subangular blocky structure parting to moderate very fine granular; soft and very friable; slightly sticky and slightly plastic; common fine and very fine roots; about 2 percent gravel; neutral; clear smooth boundary.

Btn—2 to 8 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; strong coarse columnar structure parting to strong medium angular blocky; very hard and very firm; sticky and plastic; common fine and very fine roots; many distinct clay films on faces of peds; dark gray (10YR 5/1) silt coatings on the top of columns; about 2 percent gravel; moderately alkaline; clear wavy boundary.

Btynz1—8 to 11 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; strong coarse prismatic structure parting to strong coarse subangular blocky; very hard and very firm; sticky and plastic; few very fine roots; common faint clay films on faces of peds; about 4 percent gravel; few fine masses of salt crystals; common fine irregularly shaped masses of gypsum crystals; moderately alkaline; gradual wavy boundary.

Btynz2—11 to 15 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; moderate coarse prismatic structure parting to moderate coarse subangular blocky; hard and firm; sticky and plastic; few very fine roots; common faint clay films on faces of peds; about 4 percent gravel; few fine masses of salt crystals; common fine irregularly shaped masses of gypsum crystals; slight effervescence; moderately alkaline; gradual wavy boundary.

Bk—15 to 45 inches; dark yellowish brown (10YR 4/4) clay loam, light yellowish brown (10YR 6/4) dry; common medium prominent gray (5Y 5/1) and few fine distinct dark yellowish brown (10YR 4/6) mottles; massive; hard and firm; sticky and plastic; about 6 percent gravel; few medium irregularly shaped soft masses of lime; strong effervescence; strongly alkaline; clear wavy boundary.

C—45 to 60 inches; dark yellowish brown (10YR 4/4) clay loam, light yellowish brown (10YR 6/4) dry; few fine prominent gray (5Y 5/1) and few fine distinct dark yellowish brown (10YR 4/6) mottles; massive; hard and friable; sticky and plastic; about 6 percent gravel; slight effervescence; strongly alkaline.

The E horizon has value of 3 or 4 (5 or 6 dry) and chroma of 1 or 2. The Btn horizon has value of 2 to 4. The C horizon has value of 4 or 5 (5 to 7 dry) and chroma of 2 to 4. It is loam or clay loam.

Nahon Series

The Nahon series consists of very deep, moderately well drained, very slowly permeable, sodic soils on lake

plains. These soils formed in glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Nahon silt loam, in an area of Aberdeen-Nahon silt loams, 750 feet west and 235 feet north of the southeast corner of sec. 22, T. 159 N., R. 72 W.

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

E—7 to 9 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; strong thick platy structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

Btn—9 to 17 inches; black (10YR 2/1) silty clay loam, very dark grayish brown (10YR 3/2) dry; strong coarse columnar structure parting to strong fine angular blocky; extremely hard and extremely firm; very sticky and very plastic; common very fine roots compressed on faces of peds; continuous distinct clay films on faces of peds; common fine irregularly shaped soft masses of lime in the lower part; slightly alkaline; gradual smooth boundary.

Bky1—17 to 29 inches; yellowish brown (10YR 5/4) silt loam, very pale brown (10YR 7/4) dry; weak coarse prismatic structure parting to moderate coarse subangular blocky; hard and firm; sticky and plastic; common fine masses of gypsum crystals; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Bky2—29 to 41 inches; dark yellowish brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; common fine distinct gray (10YR 5/1) mottles; weak coarse prismatic structure parting to moderate coarse subangular blocky; hard and firm; sticky and plastic; few large masses of gypsum crystals; lime disseminated throughout; strong effervescence; moderately alkaline; clear smooth boundary.

By—41 to 46 inches; dark grayish brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; common fine distinct gray (10YR 5/1) and prominent yellowish brown (10YR 5/4) mottles; massive; very hard and very firm; very sticky and very plastic; many large masses of gypsum crystals; strong effervescence; slightly alkaline; clear smooth boundary.

C—46 to 60 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; common fine prominent grayish brown (10YR 5/2) mottles; massive; slightly hard and friable; slightly sticky and slightly plastic; strong effervescence; moderately alkaline.

The A horizon has value of 2 or 3 (3 or 4 dry). The E horizon has value of 3 or 4 (5 or 6 dry) and chroma of 1 or 2. The Btn horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 to 3. The C horizon has hue of 2.5Y or 10YR, value of 4 to 7 (5 to 8 dry), and chroma of 2 to 4. It is silt loam, silty clay loam, or silty clay.

Overly Series

The Overly series consists of very deep, moderately well drained, moderately slowly permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slope ranges from 0 to 3 percent.

Typical pedon of Overly silt loam, in an area of Great Bend-Overly silt loams, 0 to 3 percent slopes, 1,600 feet north and 200 feet east of the southwest corner of sec. 21, T. 159 N., R. 69 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard and friable; slightly sticky and slightly plastic; common fine and very fine roots; neutral; abrupt smooth boundary.

A—8 to 14 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate fine granular structure; slightly hard and friable; slightly sticky and slightly plastic; common fine and very fine roots; neutral; clear smooth boundary.

Bw—14 to 21 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine prismatic structure parting to moderate fine subangular blocky; hard and firm; sticky and plastic; common fine and very fine roots; neutral; clear wavy boundary.

Bk—21 to 28 inches; grayish brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; moderate medium prismatic structure parting to weak medium subangular blocky; hard and friable; slightly sticky and slightly plastic; common fine and very fine roots; few fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; clear smooth boundary.

C1—28 to 40 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; massive; hard and friable; slightly sticky and slightly plastic; few fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

C2—40 to 60 inches; olive brown (2.5Y 4/4) silty clay loam, light yellowish brown (2.5Y 6/4) dry; few fine distinct light brownish gray (2.5Y 6/2) mottles; massive; hard and friable; sticky and plastic; few

fine roots; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has hue of 10YR or 2.5Y, value 2 to 4 (3 to 5 dry), and chroma of 1 to 3. It is silt loam or silty clay loam. The C horizon has hue 2.5Y or 5Y, value of 4 to 6, and chroma of 1 to 4.

Parnell Series

The Parnell series consists of very deep, very poorly drained, slowly permeable soils on till plains. These soils formed in alluvium and glacial till. Slope is 0 to 1 percent.

Typical pedon of Parnell silt loam, in an area of Hamerly-Tonka-Parnell complex, 0 to 3 percent slopes, 450 feet west and 130 feet south of the northeast corner of sec. 27, T. 160 N., R. 69 W.

A—0 to 11 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak coarse subangular blocky structure parting to moderate medium granular; soft and friable; slightly sticky and slightly plastic; many fine and very fine and few medium and coarse roots; neutral; clear smooth boundary.

Btg1—11 to 30 inches; black (5Y 2/1) silty clay loam, dark gray (5Y 4/1) dry; weak coarse prismatic structure parting to moderate fine and very fine subangular blocky; hard and firm; sticky and very plastic; continuous distinct clay films on faces of peds; neutral; clear wavy boundary.

Btg2—30 to 37 inches; dark olive gray (5Y 3/2) silty clay loam, olive gray (5Y 5/2) dry; common fine faint olive (5Y 4/3) mottles; moderate medium and coarse subangular blocky structure; hard and friable; sticky and plastic; many faint clay films on faces of peds; neutral; clear wavy boundary.

Cg1—37 to 45 inches; olive gray (5Y 4/2) loam, light olive gray (5Y 6/2) dry; many medium prominent olive brown (2.5Y 4/4) mottles; massive; slightly hard and friable; slightly sticky and slightly plastic; about 1 percent gravel; neutral; clear wavy boundary.

Cg2—45 to 60 inches; olive gray (5Y 4/2) clay loam, light olive gray (5Y 6/2) dry; many medium distinct olive brown (2.5Y 4/4) mottles; massive; hard and firm; sticky and plastic; very slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 24 to 60 inches. Some pedons have an O horizon, which is 1 to 2 inches thick.

The A horizon has hue of 10YR to 5Y or is neutral in hue. It has value of 2 or 3 (3 or 4 dry) and chroma of 0 or 1. The Btg horizon has hue of 10YR to 5Y and value of 3 to 5 dry. The Cg horizon has hue of 2.5Y or 5Y, value of 3 to 5 (5 to 7 dry), and chroma of 1 or 2.

Renshaw Series

The Renshaw series consists of very deep, somewhat excessively drained soils on outwash plains. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and very rapid in the lower part. Slope ranges from 0 to 3 percent.

Typical pedon of Renshaw loam, 0 to 3 percent slopes, 435 feet west and 315 feet north of the southeast corner of sec. 8, T. 161 N., R. 71 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate fine and medium granular structure; soft and friable; slightly sticky and slightly plastic; neutral; clear smooth boundary.

Bw1—6 to 11 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate coarse prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; slightly sticky and plastic; neutral; clear smooth boundary.

Bw2—11 to 16 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; slightly sticky and plastic; neutral; clear smooth boundary.

2C1—16 to 28 inches; dark grayish brown (10YR 4/2) gravelly coarse sand, light brownish gray (10YR 6/2) dry; single grain; loose; nonsticky and nonplastic; about 30 percent gravel; strong effervescence; slightly alkaline; clear smooth boundary.

2C2—28 to 38 inches; dark brown (10YR 4/3) gravelly coarse sand, pale brown (10YR 6/3) dry; single grain; loose; nonsticky and nonplastic; about 15 percent gravel; strong effervescence; slightly alkaline; gradual smooth boundary.

2C3—38 to 60 inches; dark brown (10YR 4/3) gravelly coarse sand, pale brown (10YR 6/3) dry; single grain; loose; nonsticky and nonplastic; about 22 percent gravel; slight effervescence; slightly alkaline.

The depth to sand and gravel ranges from 14 to 20 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 3 to 5 dry and chroma of 1 to 4.

Rolla Series

The Rolla series consists of very deep, moderately well drained, slowly permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slope ranges from 0 to 15 percent.

Typical pedon of Rolla silty clay, 0 to 6 percent slopes, 310 feet south and 2,400 feet west of the northeast corner of sec. 35, T. 163 N., R. 72 W.

Oi—2 inches to 0; black (N 2/0), undecomposed leaves and twigs; slightly acid; abrupt smooth boundary.

E—0 to 6 inches; dark gray (10YR 4/1) silty clay, gray (10YR 6/1) dry; weak medium platy structure parting to moderate medium and fine angular blocky; very hard and very firm; very sticky and very plastic; common fine and very fine and few medium and coarse roots; slightly acid; clear wavy boundary.

Bt1—6 to 15 inches; dark grayish brown (10YR 4/2) clay, grayish brown (10YR 5/2) dry; moderate coarse prismatic structure parting to strong medium angular blocky; extremely hard and extremely firm; very sticky and very plastic; few fine, medium, and coarse roots; continuous distinct clay films on faces of peds; slightly acid; gradual wavy boundary.

Bt2—15 to 24 inches; dark grayish brown (10YR 4/2) and dark brown (10YR 4/3) clay, grayish brown (10YR 5/2) and brown (10YR 5/3) dry; weak coarse prismatic structure parting to strong medium angular blocky; extremely hard and extremely firm; very sticky and very plastic; few fine, medium, and coarse roots; many distinct clay films on faces of peds; neutral; gradual wavy boundary.

Btk—24 to 30 inches; dark brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; moderate medium subangular blocky structure; very hard and very firm; very sticky and very plastic; few fine, medium, and coarse roots; common distinct clay films on faces of peds; few fine irregularly shaped soft masses of lime; slight effervescence; slightly alkaline; gradual wavy boundary.

C—30 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; massive; very hard and very firm; very sticky and very plastic; slight effervescence; slightly alkaline.

Some pedons have an A horizon, which is 1 to 3 inches thick. The E horizon has value of 3 or 4 (4 to 7 dry) and chroma of 1 or 2. The Bt horizon has value of 3 or 4 (4 to 6 dry) and chroma of 1 to 3. The C horizon has hue of 10YR or 2.5Y, value of 3 to 5 (5 to 7 dry), and chroma of 2 to 4.

Sioux Series

The Sioux series consists of very deep, excessively drained, very rapidly permeable soils on outwash plains. These soils formed in glaciofluvial deposits. Slope ranges from 0 to 25 percent.

Typical pedon of Sioux loam, 0 to 6 percent slopes, 1,245 feet east and 1,600 feet north of the southwest corner of sec. 35, T. 162 N., R. 73 W.

A—0 to 5 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; many very fine and fine roots; about 5 percent gravel; neutral; clear smooth boundary.

AC—5 to 9 inches; very dark grayish brown (10YR 3/2) gravelly sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; common fine and very fine roots; about 30 percent gravel; slight effervescence in the lower part; slightly alkaline; gradual smooth boundary.

C1—9 to 26 inches; dark brown (10YR 4/3) very gravelly coarse sand, pale brown (10YR 6/3) dry; single grain; loose; nonsticky and nonplastic; about 55 percent gravel; strong effervescence; moderately alkaline; clear smooth boundary.

C2—26 to 60 inches; dark brown (10YR 4/3) gravelly coarse sand, pale brown (10YR 6/3) dry; single grain; loose; nonsticky and nonplastic; about 30 percent gravel; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon and the depth to very gravelly coarse sand range from 7 to 14 inches. The A horizon has value of 2 or 3 (3 to 5 dry). It has 5 to 30 percent gravel. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It has 35 to 60 percent gravel.

Southam Series

The Southam series consists of very deep, very poorly drained, slowly permeable soils on till plains and lake plains. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Southam silt loam, 100 feet south and 2,630 feet west of the northeast corner of sec. 21, T. 162 N., R. 69 W.

Oi—3 inches to 0; very dark brown (10YR 2/2), undecomposed stems, leaves, and roots; slightly alkaline; abrupt smooth boundary.

Ag1—0 to 6 inches; black (N 2/0) silt loam, very dark gray (N 3/0) dry; weak fine and very fine subangular blocky structure; slightly hard and very friable;

slightly sticky and slightly plastic; many fine roots; slight effervescence; slightly alkaline; clear smooth boundary.

Ag2—6 to 11 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak fine and very fine subangular blocky structure; hard and firm; sticky and plastic; few fine roots; strong effervescence; slightly alkaline; gradual smooth boundary.

Ag3—11 to 26 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak fine and very fine subangular blocky structure; hard and firm; sticky and plastic; few fine roots; slight effervescence; slightly alkaline; clear wavy boundary.

Cg—26 to 60 inches; olive gray (5Y 4/2) clay loam, light olive gray (5Y 6/2) dry; common fine prominent light olive brown (2.5Y 5/4) mottles; massive; very hard and firm; sticky and plastic; slight effervescence; slightly alkaline.

The Ag horizon has hue of 2.5Y or 5Y or is neutral in hue. It has value of 2 or 3 (3 to 5 dry) and chroma of 0 to 2. The Cg horizon has hue of 2.5Y or 5Y or is neutral in hue. It has value of 3 to 7 (4 to 8 dry) and chroma of 0 to 2. It is silty clay loam or clay loam.

Stirum Series

The Stirum series consists of very deep, poorly drained, sodic, saline soils on outwash plains and lake plains. These soils formed in glaciofluvial and glaciolacustrine deposits. Permeability is moderately slow in the upper part of the profile and moderately rapid in the lower part. Slope is 0 to 1 percent.

Typical pedon of Stirum fine sandy loam, 135 feet south and 135 feet east of the northwest corner of sec. 10, T. 159 N., R. 71 W.

A—0 to 5 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine granular structure; soft and very friable; slightly sticky and slightly plastic; many very fine and fine roots; very slight effervescence; moderately alkaline; clear smooth boundary.

E—5 to 7 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; weak medium and fine subangular blocky structure; loose; nonsticky and nonplastic; common very fine and fine roots; very slight effervescence; strongly alkaline; abrupt smooth boundary.

Btkng—7 to 16 inches; gray (5Y 5/1) fine sandy loam, light gray (5Y 6/1) dry; common medium prominent light olive brown (2.5Y 5/6) mottles; strong very coarse columnar structure; very hard and firm; slightly sticky and plastic; common very fine and fine roots compressed on faces of peds; many distinct clay bridges between mineral grains; continuous very dark gray (5Y 3/1) organic stains on faces of peds; uncoated sand grains on faces of peds; lime disseminated throughout interior of peds; violent effervescence; very strongly alkaline; gradual wavy boundary.

Bkg1—16 to 26 inches; olive gray (5Y 5/2) loamy fine sand, light olive gray (5Y 6/2) dry; common fine prominent light olive brown (2.5Y 5/6) mottles; weak medium subangular blocky structure; hard and friable; nonsticky and nonplastic; few very fine and fine roots; few fine irregularly shaped soft masses of lime; strong effervescence; very strongly alkaline; clear smooth boundary.

Bkg2—26 to 35 inches; olive gray (5Y 5/2) fine sandy loam, light olive gray (5Y 6/2) dry; common fine prominent light olive brown (2.5Y 5/6) mottles; weak medium subangular blocky structure; hard and friable; slightly sticky and slightly plastic; few very fine and fine roots; many fine irregularly shaped soft masses of lime; strong effervescence; very strongly alkaline; gradual smooth boundary.

Cg1—35 to 40 inches; olive gray (5Y 5/2) loamy fine sand, light olive gray (5Y 6/2) dry; common fine prominent light yellowish brown (2.5Y 6/4) mottles; massive; hard and very friable; nonsticky and nonplastic; strong effervescence; very strongly alkaline; clear smooth boundary.

2Cg2—40 to 53 inches; dark gray (5Y 4/1) silt loam, gray (5Y 6/1) dry; many medium prominent light olive brown (2.5Y 5/6) mottles; massive; hard and friable; slightly sticky and slightly plastic; strong effervescence; strongly alkaline; gradual smooth boundary.

2Cg3—53 to 60 inches; gray (5Y 5/1) very fine sandy loam, light gray (5Y 7/1) dry; many medium prominent light olive brown (2.5Y 5/6) mottles; massive; hard and friable; slightly sticky and slightly plastic; strong effervescence; strongly alkaline.

The A horizon has hue of 10YR to 5Y or is neutral in hue. It has value of 2 or 3 (3 to 5 dry) and chroma of 0 to 2. Some pedons do not have an E horizon. The Btkng horizon has hue of 10YR to 5Y or is neutral in hue. It has value of 3 to 6 (4 to 8 dry) and chroma of 0 to 2. It is fine sandy loam or loam. The Bkg horizon has hue of 10YR to 5Y, value of 4 to 7 (5 to 8 dry), and chroma of 1 to 4. It is loamy fine sand, fine sandy loam, very fine sandy loam, or loam. The Cg horizon is loamy fine sand or fine sandy loam. Some pedons do not have a 2C horizon.

Swenoda Series

The Swenoda series consists of very deep, moderately well drained soils on till plains and lake plains. These soils formed in glacial till and glaciolacustrine deposits. Permeability is moderately rapid in the upper part of the profile and moderately slow in the lower part. Slope ranges from 0 to 3 percent.

Typical pedon of Swenoda fine sandy loam, 1,950 feet north and 2,175 feet west of the southeast corner of sec. 20, T. 159 N., R. 71 W.

Ap—0 to 6 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common fine and very fine roots; neutral; abrupt smooth boundary.

A—6 to 12 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common fine and very fine roots; slightly acid; clear smooth boundary.

Bw1—12 to 20 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; common fine roots; neutral; clear wavy boundary.

Bw2—20 to 28 inches; dark brown (10YR 3/3) fine sandy loam, brown (10YR 4/3) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few fine roots; neutral; abrupt wavy boundary.

2Bk—28 to 38 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; few fine distinct light brownish gray (2.5Y 6/2) mottles; moderate medium prismatic structure; hard and firm; sticky and plastic; few fine roots; few fine irregularly shaped masses and filaments of gypsum crystals; lime disseminated throughout; violent effervescence; slightly alkaline; clear wavy boundary.

2C—38 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; common medium distinct dark grayish brown (2.5Y 4/2) mottles; massive; hard and firm; sticky and plastic; few fine irregularly shaped masses of gypsum crystals; slight effervescence; slightly alkaline.

Depth to the 2Bk horizon ranges from 20 to 40 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 2 to 4 (3 to 5 dry) and chroma of 1 to 3. The 2Bk horizon has value of 4 to 6 (6 to 8 dry) and chroma of 2 to 5. The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (6 to 8 dry), and chroma of 2 to 5. It is loam, silt loam, clay loam, or silty clay loam.

Tonka Series

The Tonka series consists of very deep, poorly drained, slowly permeable soils on till plains. These soils formed in alluvium and glacial till. Slope is 0 to 1 percent.

Typical pedon of Tonka silt loam, in an area of Hamerly-Tonka-Parnell complex, 0 to 3 percent slopes, 100 feet south and 150 feet west of the northeast corner of sec. 13, T. 163 N., R. 70 W.

A—0 to 7 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine granular structure; soft and very friable; slightly sticky and slightly plastic; many very fine and fine roots; neutral; clear smooth boundary.

E—7 to 14 inches; dark gray (10YR 4/1) loam, gray (10YR 6/1) dry; common fine distinct dark brown (10YR 3/3) mottles; strong thin platy structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine and fine roots; slightly alkaline; clear smooth boundary.

Btg1—14 to 23 inches; black (5Y 2.5/2) silty clay loam, olive gray (5Y 4/2) dry; strong very fine subangular blocky structure; hard and firm; very sticky and very plastic; few very fine roots; common distinct clay films on faces of peds; slightly alkaline; gradual smooth boundary.

Btg2—23 to 34 inches; dark olive gray (5Y 3/2) silty clay loam, olive gray (5Y 5/2) dry; few fine prominent dark yellowish brown (10YR 4/4) mottles; strong fine subangular blocky structure; hard and firm; very sticky and very plastic; common faint clay films on faces of peds; slightly alkaline; gradual smooth boundary.

Cg—34 to 60 inches; olive gray (5Y 4/2) loam, olive gray (5Y 5/2) dry; many medium prominent olive brown (2.5Y 4/4) mottles; massive; hard and friable; sticky and plastic; slightly alkaline.

The A horizon has value of 2 or 3 (3 or 4 dry). The E horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 3 to 5 (5 to 7 dry) and chroma of 0 to 2. The Btg horizon has hue of 10YR to 5Y, value of 2 to 4 (4 to 6 dry), and chroma of 1 or 2. The Cg horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It is loam or clay loam.

Towner Series

The Towner series consists of very deep, moderately well drained soils on till plains and lake plains. These soils formed in eolian material, glaciolacustrine deposits, and glacial till. Permeability is rapid in the upper part of the profile and moderately slow in the lower part. Slope ranges from 0 to 6 percent.

Typical pedon of Towner loamy fine sand, 0 to 6 percent slopes, 1,450 feet north and 1,580 feet west of the southeast corner of sec. 27, T. 159 N., R. 73 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak coarse subangular blocky structure parting to weak fine granular; soft and very friable; nonsticky and nonplastic; few fine and very fine roots; neutral; abrupt smooth boundary.

Bw1—10 to 18 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; weak coarse subangular blocky structure; soft and very friable; nonsticky and nonplastic; few fine and very fine roots; neutral; clear smooth boundary.

Bw2—18 to 31 inches; dark brown (10YR 4/3) loamy fine sand, brown (10YR 5/3) dry; weak coarse subangular blocky structure; soft and very friable; nonsticky and nonplastic; few fine and very fine roots; neutral; gradual wavy boundary.

2C1—31 to 36 inches; brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; massive; hard and friable; slightly sticky and slightly plastic; few fine and very fine roots; about 5 percent gravel; slight effervescence; slightly alkaline; gradual wavy boundary.

2C2—36 to 60 inches; brown (10YR 5/3) loam, pale brown (10YR 6/3) dry; massive; hard and firm; slightly sticky and slightly plastic; about 10 percent gravel; violent effervescence; slightly alkaline.

The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 4 to 6 dry and chroma of 1 to 3. Some pedons have a 2Bk horizon, which is 2 to 10 inches thick. The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (6 to 8 dry), and chroma of 2 to 4. It is loam, silt loam, clay loam, or silty clay loam.

Ulen Series

The Ulen series consists of very deep, somewhat poorly drained, rapidly permeable, highly calcareous soils on lake plains (fig. 16). These soils formed in eolian material and glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Ulen fine sandy loam, 1,890 feet north and 2,070 feet west of the southeast corner of sec. 29, T. 160 N., R. 71 W.

Ap—0 to 4 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; slightly hard and very friable; slightly sticky and slightly plastic; many very fine and fine roots; strong effervescence; slightly alkaline; clear smooth boundary.

A—4 to 8 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; slightly hard and very friable; slightly sticky and slightly plastic; many very fine and fine roots; strong effervescence; slightly alkaline; clear smooth boundary.

Bk—8 to 14 inches; dark gray (10YR 4/1) loamy fine sand, gray (10YR 5/1) dry; moderate medium subangular blocky structure; slightly hard and very friable; slightly sticky and slightly plastic; many very fine roots; lime disseminated throughout; violent effervescence; moderately alkaline; clear wavy boundary.

BCk—14 to 20 inches; grayish brown (2.5Y 5/2) fine sand, light brownish gray (2.5Y 6/2) dry; few fine faint olive (5Y 5/3) mottles; weak medium subangular blocky structure; loose; nonsticky and nonplastic; common very fine roots; lime disseminated throughout; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg1—20 to 31 inches; olive (5Y 5/3) sand, pale olive (5Y 6/3) dry; common fine faint olive (5Y 4/3) mottles; single grain; loose; nonsticky and nonplastic; few very fine roots; slight effervescence; slightly alkaline; gradual wavy boundary.

Cg2—31 to 52 inches; olive (5Y 5/3) sand, pale olive (5Y 6/3) dry; many large prominent dark yellowish brown (10YR 4/6) mottles; single grain; loose; nonsticky and nonplastic; slight effervescence; moderately alkaline; gradual wavy boundary.

Cg3—52 to 60 inches; olive (5Y 4/3) sand, pale olive (5Y 6/3) dry; many large distinct gray (5Y 5/1) mottles; single grain; loose; nonsticky and nonplastic; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 8 to 20 inches. The A horizon has value of 2 or 3 (3 or 4 dry). Some pedons have an Ak horizon, which is 2 to 6 inches thick. The Bk horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 to 7 dry), and chroma of 1 to 3. It is loamy fine sand or fine sand. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (6 or 7 dry), and chroma of 2 to 6.

Vallers Series

The Vallers series consists of very deep, poorly drained, moderately slowly permeable, highly calcareous, saline soils on till plains. These soils formed in glacial till. Slope is 0 to 1 percent.

Typical pedon of Vallers loam, saline, 1,300 feet south and 400 feet east of the northwest corner of sec. 26, T. 162 N., R. 69 W.

Az—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; common fine and very fine roots; about 1 percent gravel; common fine masses of salt crystals; slight effervescence; slightly alkaline; abrupt smooth boundary.

Bk1—8 to 14 inches; light brownish gray (10YR 6/2) loam, light gray (10YR 7/1) dry; few fine and medium distinct yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few fine and very fine roots; about 1 percent gravel; lime disseminated throughout; violent effervescence; moderately alkaline; clear smooth boundary.

Bk2—14 to 30 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; common fine and medium prominent yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; about 2 percent gravel; common medium irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear smooth boundary.

C1—30 to 51 inches; dark grayish brown (2.5Y 4/2) loam, grayish brown (2.5Y 5/2) dry; common fine and medium prominent yellowish brown (10YR 5/4) mottles; massive; slightly hard and firm; slightly sticky and slightly plastic; about 3 percent gravel; strong effervescence; slightly alkaline; gradual smooth boundary.

C2—51 to 60 inches; dark grayish brown (2.5Y 4/2) loam, grayish brown (2.5Y 5/2) dry; common fine and medium prominent yellowish brown (10YR 5/4) mottles; massive; slightly hard and firm; slightly sticky and slightly plastic; about 5 percent gravel; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3 (3 to 5 dry) and chroma of 0 or 1. The Bk horizon has hue of 10YR to 5Y, value of 3 to 6 (5 to 8 dry), and chroma of 1 or 2. The C horizon has hue of 2.5Y or 5Y, value of 4 to 7 (5 to 8 dry), and chroma of 1 to 3.

Wyndmere Series

The Wyndmere series consists of very deep, somewhat poorly drained, moderately rapidly permeable, highly calcareous soils on lake plains (fig. 17). These soils formed in glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Wyndmere fine sandy loam, 1,270 feet east and 430 feet north of the southwest corner of sec. 17, T. 160 N., R. 73 W.

Ap—0 to 7 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine and medium granular structure; soft and friable; slightly sticky and slightly plastic; few very fine roots; violent effervescence; moderately alkaline; abrupt smooth boundary.

Bk1—7 to 12 inches; dark grayish brown (10YR 4/2) fine sandy loam, light brownish gray (10YR 6/2) dry; moderate medium and coarse subangular blocky structure; soft and friable; slightly sticky and slightly plastic; few very fine roots; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk2—12 to 24 inches; dark brown (10YR 4/3) fine sandy loam, pale brown (10YR 6/3) dry; moderate coarse and medium subangular blocky structure; soft and friable; slightly sticky and slightly plastic; few very fine roots; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk3—24 to 29 inches; grayish brown (2.5Y 5/2) fine sandy loam, light gray (2.5Y 7/2) dry; moderate medium and coarse subangular blocky structure; soft and friable; slightly sticky and slightly plastic; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—29 to 45 inches; olive (5Y 5/3) loamy fine sand, pale yellow (5Y 7/3) dry; common fine distinct light olive brown (2.5Y 5/4) and few fine distinct grayish brown (2.5Y 5/2) mottles; single grain; loose; nonsticky and nonplastic; strong effervescence; moderately alkaline; clear wavy boundary.

C2—45 to 60 inches; olive (5Y 5/4) loamy fine sand, pale yellow (5Y 7/4) dry; many coarse distinct olive gray (5Y 5/2) mottles; single grain; loose; nonsticky and nonplastic; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. In some pedons the soils are saline.

The A horizon has value of 2 or 3 (3 to 5 dry). The Bk horizon has value of 3 to 6 (4 to 8 dry) and chroma of 1 to 3. The C horizon has hue of 10YR to 5Y, value

of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. Some pedons have a 2C horizon at a depth of 40 to 60 inches. This horizon is loam, silt loam, or silty clay loam.

Wyrene Series

The Wyrene series consists of very deep, somewhat poorly drained, moderately rapidly permeable, highly calcareous soils on outwash plains. These soils formed in glaciofluvial deposits. Slope is 0 to 1 percent.

Typical pedon of Wyrene sandy loam, 2,230 feet south and 1,660 feet west of the northeast corner of sec. 6, T. 161 N., R. 72 W.

Ap—0 to 5 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to weak medium granular; soft and friable; slightly sticky and slightly plastic; common very fine roots; about 5 percent gravel; neutral; abrupt smooth boundary.

A—5 to 8 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; soft and friable; slightly sticky and slightly plastic; common very fine roots; about 5 percent gravel; very slight effervescence; slightly alkaline; clear wavy boundary.

Bk1—8 to 15 inches; dark gray (10YR 4/1) sandy loam, gray (10YR 5/1) dry; moderate coarse subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; about 5 percent gravel; lime disseminated throughout; violent effervescence; slightly alkaline; clear wavy boundary.

Bk2—15 to 24 inches; grayish brown (10YR 5/2) sandy loam, light brownish gray (10YR 6/2) dry; few fine prominent olive brown (2.5Y 4/4) mottles; weak medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; about 10 percent gravel; lime disseminated throughout; violent effervescence; moderately alkaline; clear smooth boundary.

2C1—24 to 44 inches; brown (10YR 4/3) gravelly coarse sand, pale brown (10YR 6/3) dry; few medium distinct olive brown (2.5Y 4/4) mottles; single grain; loose; nonsticky and nonplastic; about 30 percent gravel; strong effervescence; slightly alkaline; gradual wavy boundary.

2C2—44 to 49 inches; olive brown (2.5Y 4/4) coarse sand, light yellowish brown (2.5Y 6/4) dry; single grain; loose; nonsticky and nonplastic; about 7 percent gravel; slight effervescence; slightly alkaline; clear wavy boundary.

2C3—49 to 60 inches; dark grayish brown (2.5Y 4/2) gravelly coarse sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; nonsticky and nonplastic; about 30 percent gravel; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. Depth to the 2C horizon ranges from 20 to 32 inches.

The A horizon has hue of 10YR or 2.5Y and value of 2 or 3 (3 to 5 dry). The Bk horizon has hue of 10YR or 2.5Y and value of 3 to 5 (5 to 7 dry). It is sandy loam or coarse sandy loam. The 2C horizon has hue of 10YR to 5Y, value of 3 to 6 (5 to 8 dry), and chroma of 1 to 4. It is gravelly coarse sand, coarse sand, or sand.

Formation of the Soils

Soil forms through processes acting on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time that the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for the transformation of the parent material into a soil. Some time is always required for the differentiation of soil horizons.

Parent Material

The soils in Rolette County formed mainly in glacial drift. The advancing glacier picked up rocks and soil, ground and mixed them, and deposited the material as the ice melted from the receding glacier. Barnes, Heimdal, and other soils formed in unsorted material, or glacial till. Glyndon, Bearden, and other soils formed in glaciolacustrine deposits, or glacial material deposited by water in glacial lakes. Divide, Sioux, and other soils formed in glaciofluvial deposits, or material deposited by glacial meltwater. Hecla, Maddock, and other soils formed in eolian material, or material deposited in glacial lakes and then moved about by the wind.

Climate

Climate has direct and indirect effects on the formation of soils. Precipitation, temperature, and wind directly affect the weathering and reworking of parent material. Climate indirectly affects soil formation through its effects on the amount and kind of plant and animal life on or in the soils.

In addition to weathering the parent material, precipitation and temperature affect the leaching and redistribution of carbonates and clay particles and the accumulation of organic matter in the soils. Freezing and thawing help to break down soil particles in the parent material, thereby providing more surface area for chemical processes. Cool temperatures affect the content of organic matter by slowing the decay of plant material and animal remains.

Rolette County has a continental, semiarid climate characterized by long, cold winters and short, warm summers. Most of the precipitation falls during the growing season and is distributed in an erratic pattern.

The Turtle Mountains receive slightly more precipitation than the other parts of the county. As a result, Kelvin, Rolla, and other soils in the mountains have undergone a higher degree of leaching than the other soils in the county.

Plant and Animal Life

Most of the soils in Rolette County formed under grassland vegetation. Embden and Gardena soils are examples. Kelvin, Rolla, and other soils in the Turtle Mountains formed under trees. These soils were subject to a greater amount of leaching than the soils that formed under grasses. Grasses provide a plentiful supply of organic material, which improves the chemical and physical properties of the soils. The fibrous roots of these grasses penetrate the soils to a depth of several feet, making them more porous and more granular. As a result of these changes in the soils, less water runs off the surface and more moisture is available for increased microbiological activity. The decay of plants improves the available water capacity, tilth, and fertility of the soils. The accumulation of decayed organic matter over long periods results in a dark surface layer.

Micro-organisms have important effects on soil formation because they feed on undecomposed organic matter and convert it into humus, from which plants can obtain nutrients. Bacteria and different kinds of fungi attack leaves and other forms of organic matter. Insects, earthworms, and small burrowing animals help to mix the humus with the soils.

Human activities greatly affect soil formation. Management measures can alter drainage. They can help to control erosion, thus maintaining fertility. Poor management can increase the susceptibility to erosion and thus result in an unproductive soil.

Relief

The slope of the soils in Rolette County ranges from level to very steep. The degree of slope and the shape of the surface affect each soil through their effects on runoff and internal drainage.

On Buse, Esmond, and other soils in areas where slopes are steep, much of the precipitation is lost as runoff. Vegetation is sparse, leaching is restricted, and profile development is slow. Barnes, Emrick, and other soils in the lower areas receive runoff from the Buse, Esmond, and other soils because of their position on the landscape. As a result, the rate of plant growth and the extent of leaching and profile development are increased.

Hamerly soils, which are on flats and around depressions, have accumulated lime in the upper part. The lime moves to the surface with the seasonal high water table through capillary action. As the water is removed through evapotranspiration, lime accumulates in the surface layer and subsoil. In some areas soluble salts also accumulate.

Soils in depressions vary widely in profile development, depending on the degree of wetness. Tonka soils, which are in shallow depressions, exhibit an advanced degree of horizonation because of the alternating wet and dry cycles that occur in the depressions. Because of the increased moisture in the depressions, these soils have properties much like those of soils in areas of much higher precipitation. Southam soils, which are in deep depressions and are nearly continuously wet, have a thick surface layer and have carbonates throughout. The horizonation of these soils is mostly the result of sedimentary processes rather than soil-forming processes *(4)*.

Time

Soil formation is a very slow process. Much time is required for the processes of soil formation to act on the parent material and to form distinct soil horizons. Approximately 10,000 to 12,000 years have passed since the last glacier receded from Rolette County. In geological terms the soils in the county are young.

More time has been available for the formation of Cathay soils on flats on till plains than for the formation of Southam soils in depressions on the till plains. The forces of soil formation have been continually acting on the parent material of the Cathay soils. Southam soils, however, are continually receiving new parent material as a result of surface runoff. Cathay soils have well defined horizons, whereas Southam soils have less distinct horizons.

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Glossary

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

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:

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

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 textured soil. Sand or loamy sand.

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.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of 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.

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.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Depth, soil. The depth of soil over bedrock. A very shallow soil is less than 10 inches deep over bedrock; a shallow soil, 10 to 20 inches; a moderately deep soil, 20 to 40 inches; a deep soil, 40 to 60 inches; and a very deep soil, more than 60 inches.

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.

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 human or animal activities or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Excess sodium (in tables). Excess exchangeable sodium in the soil. The resulting poor physical properties restrict the growth of plants.

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.

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.

Fine textured soil. Sandy clay, silty clay, or clay.

Flood plain. A nearly level alluvial plain that borders a

stream and is subject to flooding unless protected artificially.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

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 meltwater.

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 meltwater. Many deposits are interbedded or laminated.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

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 uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Lake plain. A nearly level area marking the floor of an extinct lake filled with well sorted, stratified sediments.

Leaching. The removal of soluble material from soil or other material by percolating water.

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

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, or silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

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.)

Mucky peat. Dark colored organic soil material intermediate in degree of decomposition between muck and peat. (See Hemic soil material.)

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

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.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

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.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor on the basis of how much the present plant community has departed from the potential.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Ultra acid	below 3.5
Extremely acid	3.5 to 4.4

Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Moderately acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Slightly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root shearing. The cutting, tearing, and disruption of plant roots by the hooves of animals in areas that are grazed when the soil is wet and soft.

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.

Saline-sodic soil. A soil containing enough soluble salts and exchangeable sodium to interfere with the growth of plants.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

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.

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 substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slick spot. A small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

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. In this survey the slope classes are:

Level	0 to 1 percent
Level and nearly level	0 to 3 percent
Nearly level	1 to 3 percent
Gently sloping or undulating	3 to 6 percent
Moderately sloping or gently rolling	6 to 9 percent
Strongly sloping or rolling	9 to 15 percent
Moderately steep or hilly	15 to 25 percent
Steep	25 to 35 percent
Very steep	more than 35 percent

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Sodicity. The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium adsorption ratio (SAR) of a saturation extract, or the ratio of Na^{+} to $Ca^{++} + Mg^{++}$. The degrees of sodicity and their respective ratios are:

Slight	less than 13:1
Moderate	13-30:1
Strong	more than 30:1

Sodic soil. See Alkali (sodic) soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between

specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the substratum. The living roots and plant and animal activities are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from soil blowing 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.

Substratum. The part of the soil below the solum.

Subsurface layer. An E horizon below an A horizon. If the E horizon is exposed, it is called 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. An A horizon that is 4 to 9 inches (10 to 24 centimeters) thick.

Surface soil. An A horizon that is 10 inches (25 centimeters) or more thick.

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.

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). A layer of otherwise suitable soil material that is too thin for the specified use.

Till plain. An extensive area of nearly level to undulating soils underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

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.

Wind-sculptured area. An area where the form of the land surface has been changed by the wind.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-86 at the Belcourt Indian Reservation)

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	13.0	-9.2	1.9	45	-39	0	0.49	0.18	0.75	2	7.7
February	20.2	-2.4	8.9	47	-37	0	.40	.08	.64	2	6.7
March	31.0	9.0	20.0	57	-30	29	.63	.19	.98	3	7.6
April	49.7	25.4	37.6	80	-1	108	1.45	.29	2.35	4	4.2
May	64.3	37.4	50.9	87	16	350	2.26	.78	3.47	5	1.0
June	73.0	47.1	60.1	92	29	603	3.29	1.58	4.75	7	.0
July	79.2	52.2	65.7	96	35	797	2.87	1.13	4.33	6	.0
August	77.8	49.7	63.8	94	32	738	2.94	1.20	4.41	6	.0
September	65.6	39.2	52.4	90	20	378	1.98	.72	3.02	5	.2
October	54.4	29.4	41.9	78	7	151	1.08	.27	1.72	3	1.8
November	33.4	14.1	23.8	62	-17	21	.48	.11	.77	2	5.7
December	19.5	-1.2	9.2	47	-35	0	.46	.14	.71	2	5.7
Yearly:											
Average	48.4	25.3	36.4	---	---	---	---	---	---	---	---
Extreme	---	---	---	97	-41	---	---	---	---	---	---
Total	---	---	---	---	---	3,175	18.33	14.22	22.19	47	40.6

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

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-86 at the Belcourt Indian Reservation)

Probability	Temperature		
	24 °F or lower	28 °F or lower	32 °F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 25	June 5	June 21
2 years in 10 later than--	May 20	May 30	June 14
5 years in 10 later than--	May 8	May 18	June 1
First freezing temperature in fall:			
1 year in 10 earlier than--	Sept. 14	Sept. 6	Aug. 23
2 years in 10 earlier than--	Sept. 20	Sept. 11	Aug. 29
5 years in 10 earlier than--	Oct. 1	Sept. 20	Sept. 9

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-86 at the Belcourt Indian Reservation)

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	119	100	70
8 years in 10	128	108	80
5 years in 10	145	124	99
2 years in 10	162	140	117
1 year in 10	171	148	127

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
17	Aberdeen-Nahon silt loams	11,380	1.9
64	Arveson loam	3,490	0.6
66	Arveson loam, wet	1,000	0.2
76	Arvilla sandy loam, 0 to 6 percent slopes	11,410	1.9
118	Barnes-Buse loams, 3 to 6 percent slopes	76,720	12.7
120	Barnes-Buse loams, 6 to 9 percent slopes	16,720	2.8
135	Barnes-Cresbard loams, 3 to 6 percent slopes	1,800	0.3
137	Barnes-Hamerly loams, 0 to 3 percent slopes	50,270	8.3
167	Bearden silt loam	4,510	0.7
169	Bearden silt loam, saline, 0 to 3 percent slopes	4,670	0.8
268	Bottineau loam, 3 to 9 percent slopes	17,980	3.0
271	Bottineau loam, 9 to 25 percent slopes	17,770	3.0
314	Buse-Barnes loams, 9 to 15 percent slopes	9,240	1.5
318	Buse-Barnes loams, 15 to 25 percent slopes	8,950	1.5
389	Cathay-Larson loams, 0 to 6 percent slopes	2,530	0.4
392	Cavour-Cresbard loams, 0 to 6 percent slopes	2,970	0.5
430	Claire-Lohnes complex, 6 to 25 percent slopes	3,810	0.6
450	Colvin silt loam	5,310	0.9
451	Colvin silt loam, channeled	5,130	0.9
452	Colvin silt loam, saline	3,740	0.6
453	Colvin silt loam, wet	1,970	0.3
470	Cresbard-Barnes loams, 0 to 3 percent slopes	6,870	1.1
501	Dickey-Esmond complex, 3 to 9 percent slopes	6,490	1.1
502	Dickey-Esmond-Maddock complex, 9 to 25 percent slopes	2,670	0.4
510	Divide loam	9,060	1.5
532	Eckman silt loam, 1 to 6 percent slopes	2,490	0.4
548	Egeland fine sandy loam, 0 to 6 percent slopes	5,730	1.0
569	Embden fine sandy loam	1,930	0.3
601	Eramosh peat	5,440	0.9
602	Eramosh peat, ponded	3,510	0.6
605	Esmond-Heimdal loams, 9 to 15 percent slopes	3,180	0.5
607	Esmond-Heimdal loams, 15 to 25 percent slopes	1,130	0.2
768	Gardena silt loam	1,570	0.3
800	Glyndon silt loam	2,860	0.5
846	Great Bend-Overly silt loams, 0 to 3 percent slopes	4,680	0.8
863	Hamerly loam, 0 to 3 percent slopes	3,090	0.5
864	Hamerly loam, saline, 0 to 3 percent slopes	3,260	0.5
883	Hamerly-Tonka-Parnell complex, 0 to 3 percent slopes	33,630	5.6
893	Harriet silt loam	11,430	1.9
926	Hecla loamy fine sand, 0 to 3 percent slopes	11,200	1.9
939	Hecla-Hamar loamy fine sands, 0 to 3 percent slopes	3,470	0.6
987	Heimdal-Emrick loams, 0 to 3 percent slopes	1,930	0.3
992	Heimdal-Emrick-Esmond loams, 3 to 6 percent slopes	5,720	1.0
998	Heimdal-Esmond loams, 6 to 9 percent slopes	3,600	0.6
1013	Kelvin loam, 3 to 9 percent slopes	31,420	5.2
1014	Kelvin loam, 9 to 25 percent slopes	32,970	5.5
1104	Lanona-Swenoda fine sandy loams, 1 to 6 percent slopes	4,630	0.8
1140	Letcher fine sandy loam, 0 to 6 percent slopes	6,120	1.0
1182	Lohnes loamy sand, 0 to 6 percent slopes	6,310	1.0
1206	Maddock loamy fine sand, 6 to 25 percent slopes	2,530	0.4
1221	Maddock-Hecla loamy fine sands, 1 to 6 percent slopes	22,440	3.7
1269	Marysland silt loam	4,030	0.7
1291	Metigoshe sandy loam, 3 to 9 percent slopes	1,430	0.2
1292	Metigoshe sandy loam, 9 to 25 percent slopes	1,970	0.3
1300	Miranda-Cavour loams	1,530	0.3
1426	Parnell silt loam	2,790	0.5
1466	Pits, sand and gravel	440	0.1
1523	Renshaw loam, 0 to 3 percent slopes	4,080	0.7
1571	Rolla silty clay, 0 to 6 percent slopes	17,600	2.9
1572	Rolla silty clay, 6 to 15 percent slopes	3,360	0.6
1687	Sioux loam, 0 to 6 percent slopes	5,650	0.9
1691	Sioux loam, 6 to 25 percent slopes	3,630	0.6
1709	Southam silt loam	3,860	0.6

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
1727	Stirum fine sandy loam	6,370	1.1
1780	Swenoda fine sandy loam	2,730	0.5
1843	Towner loamy fine sand, 0 to 6 percent slopes	4,800	0.8
1859	Ulen fine sandy loam	3,230	0.5
1871	Vallers loam, saline	1,470	0.2
1978	Water	23,240	3.9
2046	Wyndmere fine sandy loam	3,830	0.6
2059	Wyrene sandy loam	2,730	0.5
	Total	601,500	100.0

TABLE 5.--YIELDS PER ACRE OF CROPS

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the map unit is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Rye	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Bu	Lbs	Tons
17*---------- Aberdeen-Nahon	24	51	39	12	31	1,200	1.6
64---------- Arveson	12	26	20	6	---	600	2.8
66---------- Arveson	4	9	7	2	---	200	2.8
76---------- Arvilla	15	32	24	8	19	750	1.7
118*---------- Barnes-Buse	26	55	42	13	33	1,300	2.2
120*---------- Barnes-Buse	22	47	36	11	38	1,100	2.1
135*---------- Barnes-Cresbard	28	60	49	14	36	1,400	2.1
137*---------- Barnes-Hamerly	33	70	54	17	42	1,650	2.5
167---------- Bearden	35	74	57	18	45	1,750	2.4
169---------- Bearden	20	43	33	10	26	1,000	2.2
268---------- Bottineau	27	57	44	14	34	1,350	2.4
271---------- Bottineau	---	---	---	---	---	---	2.6
314*---------- Buse-Barnes	---	---	---	---	---	---	1.9
318*---------- Buse-Barnes	---	---	---	---	---	---	1.9
389*---------- Cathay-Larson	22	47	36	11	28	1,100	1.7
392*---------- Cavour-Cresbard	20	43	33	10	26	1,000	1.5
430*---------- Claire-Lohnes	---	---	---	---	---	---	1.8
450---------- Colvin	16	34	26	8	20	800	2.8
451---------- Colvin	---	---	---	---	---	---	2.8

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Rye	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Bu	Lbs	Tons
452---------- Colvin	9	19	15	5	11	450	2.2
453---------- Colvin	4	9	7	2	---	200	---
470*---------- Cresbard-Barnes	30	64	49	15	38	1,500	2.0
501*---------- Dickey-Esmond	15	32	24	8	19	750	1.6
502*---------- Dickey-Esmond-Maddock	---	---	---	---	---	---	1.6
510---------- Divide	24	51	39	12	31	1,200	2.2
532---------- Eckman	34	72	55	17	43	1,700	2.5
548---------- Egeland	25	53	41	13	32	1,250	2.1
569---------- Embden	30	64	49	15	38	1,500	2.1
601, 602---------- Eramosh	---	---	---	---	---	---	---
605*---------- Esmond-Heimdal	---	---	---	---	---	---	1.9
607*---------- Esmond-Heimdal	---	---	---	---	---	---	1.9
768---------- Gardena	40	85	65	20	51	2,000	2.6
800---------- Glyndon	36	77	59	18	46	1,800	2.3
846*---------- Great Bend-Overly	37	79	60	19	47	1,850	2.5
863---------- Hamerly	33	70	54	17	42	1,650	2.3
864---------- Hamerly	20	43	33	10	26	1,000	2.1
883*---------- Hamerly-Tonka-Parnell	24	51	39	12	31	1,200	2.0
893---------- Harriet	---	---	---	---	---	---	1.6
926---------- Hecla	20	43	33	10	26	1,000	1.9

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Rye	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Bu	Lbs	Tons
939*----- Hecla-Hamar	20	43	33	10	26	1,000	2.3
987*----- Heimdal-Emrick	33	70	54	17	42	1,650	2.6
992*----- Heimdal-Emrick-Esmond	26	55	42	13	33	1,300	2.3
998*----- Heimdal-Esmond	19	40	31	10	24	950	2.1
1013----- Kelvin	27	57	44	14	---	1,350	2.4
1014----- Kelvin	---	---	---	---	---	---	2.6
1104*----- Lanona-Swenoda	27	57	44	14	34	1,350	2.1
1140----- Letcher	12	26	20	6	15	600	1.6
1182----- Lohnes	14	30	23	7	18	700	1.5
1206----- Maddock	---	---	---	---	---	---	1.8
1221*----- Maddock-Hecla	16	34	26	8	20	800	1.8
1269----- Marysland	13	28	21	7	17	650	2.8
1291----- Metigoshe	19	40	31	10	24	950	1.3
1292----- Metigoshe	---	---	---	---	---	---	1.0
1300*----- Miranda-Cavour	---	---	---	---	---	---	1.2
1426----- Parnell	8	17	13	4	---	400	2.8
1466. Pits, sand and gravel							
1523----- Renshaw	17	36	28	9	22	900	1.8
1571----- Rolla	28	60	46	14	36	1,400	2.1
1572----- Rolla	21	45	34	11	27	1,050	1.9

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Rye	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Bu	Lbs	Tons
1687---------- Sioux	---	---	---	---	---	---	1.0
1691---------- Sioux	---	---	---	---	---	---	1.0
1709. Southam							
1727---------- Stirum	---	---	---	---	---	---	1.6
1780---------- Swenoda	31	66	50	16	40	1,550	2.1
1843---------- Towner	20	43	33	10	26	1,000	1.8
1859---------- Ulen	22	47	36	11	28	1,100	2.3
1871---------- Vallers	9	19	15	5	11	450	2.1
1978. Water							
2046---------- Wyndmere	28	60	46	14	36	1,400	2.3
2059---------- Wyrene	20	43	33	10	26	1,000	2.2

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--RANGELAND PRODUCTIVITY

(Only the soils that support rangeland vegetation suitable for grazing are listed)

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
17*:				
Aberdeen	Clayey	2,500	2,100	1,700
Nahon	Claypan	2,000	1,800	1,500
64 Arveson	Subirrigated	4,400	4,000	3,600
66 Arveson	Wetland	6,500	6,000	5,500
76 Arvilla	Shallow to Gravel	2,000	1,700	1,400
118*, 120*:				
Barnes	Silty	2,800	2,500	2,100
Buse	Thin Upland	2,600	2,200	1,800
135*:				
Barnes	Silty	2,800	2,500	2,100
Cresbard	Clayey	2,500	2,100	1,700
137*:				
Barnes	Silty	2,800	2,500	2,100
Hamerly	Limy Subirrigated	4,200	3,800	3,200
167 Bearden	Limy Subirrigated	4,200	3,800	3,200
169 Bearden	Saline Lowland	3,400	3,000	2,600
314*, 318*:				
Buse	Thin Upland	2,600	2,200	1,800
Barnes	Silty	2,800	2,500	2,100
389*:				
Cathay	Clayey	2,500	2,100	1,700
Larson	Claypan	2,000	1,800	1,500
392*:				
Cavour	Claypan	2,000	1,800	1,500
Cresbard	Clayey	2,500	2,100	1,700
430*:				
Claire	Thin Sands	2,000	1,600	1,300
Lohnes	Sands	2,800	2,400	2,000
450, 451 Colvin	Subirrigated	4,800	4,300	3,800

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
452---------- Colvin	Saline Lowland----------	3,400	3,000	2,600
453---------- Colvin	Wetland----------	6,500	6,000	5,500
470*:				
Cresbard----------	Clayey----------	2,500	2,100	1,700
Barnes----------	Silty----------	2,800	2,500	2,100
501*:				
Dickey----------	Sands----------	3,100	2,700	2,300
Esmond----------	Thin Upland----------	2,600	2,200	1,800
502*:				
Dickey----------	Sands----------	3,100	2,700	2,300
Esmond----------	Thin Upland----------	2,600	2,200	1,800
Maddock----------	Sands----------	3,100	2,700	2,300
510---------- Divide	Limy Subirrigated----------	4,200	3,800	3,200
532---------- Eckman	Silty----------	2,800	2,500	2,100
548---------- Egeland	Sandy----------	2,900	2,500	2,100
569---------- Embden	Sandy----------	2,900	2,500	2,100
601---------- Eramosh	Wetland----------	6,500	6,000	5,500
605*, 607*:				
Esmond----------	Thin Upland----------	2,600	2,200	1,800
Heimdal----------	Silty----------	2,800	2,500	2,100
768---------- Gardena	Silty----------	2,900	2,600	2,200
800---------- Glyndon	Limy Subirrigated----------	4,200	3,800	3,200
846*:				
Great Bend----------	Silty----------	2,800	2,500	2,100
Overly----------	Silty----------	2,900	2,600	2,200
863---------- Hamerly	Limy Subirrigated----------	4,200	3,800	3,200
864---------- Hamerly	Saline Lowland----------	3,400	3,000	2,600

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
883*:				
Hamerly	Limy Subirrigated	4,200	3,800	3,200
Tonka	Wet Meadow	4,800	4,300	4,100
Parnell	Wetland	6,500	6,000	5,500
893--Harriet	Saline Lowland	3,200	2,800	2,400
926--Hecla	Sands	3,100	2,700	2,300
939*:				
Hecla	Sands	3,100	2,700	2,300
Hamar	Subirrigated	4,400	4,000	3,600
987*:				
Heimdal	Silty	2,800	2,500	2,100
Emrick	Overflow	3,600	3,200	2,700
992*:				
Heimdal	Silty	2,800	2,500	2,100
Emrick	Silty	2,900	2,600	2,200
Esmond	Thin Upland	2,600	2,200	1,800
998*:				
Heimdal	Silty	2,800	2,500	2,100
Esmond	Thin Upland	2,600	2,200	1,800
1104*:				
Lanona	Sandy	2,900	2,500	2,100
Swenoda	Sandy	2,900	2,500	2,100
1140--Letcher	Sandy Claypan	3,500	2,500	1,500
1182--Lohnes	Sands	2,800	2,400	2,000
1206--Maddock	Sands	3,100	2,700	2,300
1221*:				
Maddock	Sands	3,100	2,700	2,300
Hecla	Sands	3,100	2,700	2,300
1269--Marysland	Subirrigated	4,400	4,000	3,600
1300*:				
Miranda	Thin Claypan	1,100	900	700

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
1300*: Cavour	Claypan	2,000	1,800	1,500
1426 Parnell	Wetland	6,500	6,000	5,500
1523 Renshaw	Shallow to Gravel	2,000	1,700	1,400
1687, 1691 Sioux	Very Shallow	1,100	900	700
1727 Stirum	Subirrigated	4,400	4,000	3,600
1780 Swenoda	Sandy	2,900	2,500	2,100
1843 Towner	Sands	3,100	2,700	2,300
1859 Ulen	Limy Subirrigated	4,800	4,200	3,600
1871 Vallers	Saline Lowland	3,200	2,800	2,400
2046 Wyndmere	Limy Subirrigated	4,200	3,800	3,200
2059 Wyrene	Limy Subirrigated	4,200	3,800	3,200

* 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 height, in feet, of--				
	<8	8-15	16-25	26-35	>35
17*:					
Aberdeen	---	Eastern redcedar, Siberian peashrub, Russian-olive, lilac, Peking cotoneaster, common chokecherry, silver buffaloberry.	Siberian elm, Siberian crabapple, green ash, ponderosa pine.	---	---
Nahon	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry, lilac.	Siberian elm, green ash, ponderosa pine, Russian-olive, eastern redcedar.	---	---	---
64, 66 Arveson	---	Common chokecherry, redosier dogwood, lilac, Siberian peashrub, eastern redcedar, American plum.	Siberian crabapple, Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
76 Arvilla	Silver buffaloberry, Siberian peashrub, lilac.	Green ash, Russian-olive, Siberian crabapple, eastern redcedar, Rocky Mountain juniper, common chokecherry.	Ponderosa pine	---	---
118*, 120*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Buse	Siberian peashrub	Green ash, eastern redcedar, ponderosa pine, Russian-olive, Rocky Mountain juniper.	Siberian elm	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
135*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Cresbard	Peking cotoneaster	Russian-olive, common chokecherry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
137*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Hamerly	---	Redosier dogwood, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
167 Bearden	---	Redosier dogwood, ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Peking cotoneaster, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
169 Bearden	Siberian peashrub, silver buffaloberry.	---	Siberian elm, green ash, Russian-olive.	---	---
268 Bottineau	---	Lilac, eastern redcedar, redosier dogwood, Siberian peashrub, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce, Russian-olive.	---	---
271. Bottineau					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
314*: Buse.					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
318*: Buse.					
Barnes.					
389*: Cathay	---	Common chokecherry, eastern redcedar, Peking cotoneaster, Russian-olive, silver buffaloberry, Siberian peashrub, lilac.	Siberian elm, green ash, ponderosa pine, Siberian crabapple.	---	---
Larson	Rocky Mountain juniper, Siberian peashrub, silver	Siberian elm, green ash, ponderosa pine, eastern redcedar.	---	---	---
392*: Cavour	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian-olive, eastern redcedar.	---	---	---
Cresbard	Peking cotoneaster	Russian-olive, common chokecherry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
430*: Claire.					
Lohnes.					
450 Colvin	---	American plum, Siberian peashrub, common chokecherry, lilac, eastern redcedar, redosier dogwood.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
451. Colvin					
452---------- Colvin	Silver buffaloberry, Siberian peashrub.	---	Russian-olive, green ash, Siberian elm.	---	---
453---------- Colvin	---	American plum, Siberian peashrub, eastern redcedar, redosier dogwood, lilac.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow-----	Eastern cottonwood, Siberian elm.
470*:					
Cresbard---------	Peking cotoneaster	Russian-olive, common chokecherry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
Barnes----------	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
501*:					
Dickey.					
Esmond----------	Siberian peashrub	Green ash, ponderosa pine, Russian-olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm------	---	---
502*:					
Dickey.					
Esmond.					
Maddock.					
510---------- Divide	---	Redosier dogwood, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
532---------- Eckman	---	Eastern redcedar, American plum, lilac, redosier dogwood, Siberian peashrub.	Ponderosa pine, green ash, bur oak, Black Hills spruce, Russian-olive, Siberian crabapple.	---	---
548---------- Egeland	---	Common chokecherry, Siberian peashrub, eastern redcedar, American plum, silver buffaloberry, Siberian crabapple, lilac.	Green ash, bur oak, ponderosa pine, Russian-olive.	---	---
569---------- Embden	---	Peking cotoneaster, ponderosa pine, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub, American plum.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
601, 602. Eramosh					
605*: Esmond.					
Heimdal----------	---	Eastern redcedar, lilac, American plum, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
607*: Esmond.					
Heimdal.					
768---------- Gardena	---	American plum, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
800---------- Glyndon	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, redosier dogwood.	Black Hills spruce, green ash.	Golden willow-----	Eastern cottonwood.
846*:					
Great Bend-------	---	Eastern redcedar, redosier dogwood, American plum, Siberian peashrub, lilac.	Ponderosa pine, Black Hills spruce, green ash, Russian-olive, bur oak, Siberian crabapple.	---	---
Overly----------	---	Siberian peashrub, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
863---------- Hamerly	---	Redosier dogwood, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
864---------- Hamerly	Silver buffaloberry, Siberian peashrub.	---	Siberian elm, Russian-olive, green ash.	---	---
883*:					
Hamerly----------	---	Redosier dogwood, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
Tonka----------	---	Eastern redcedar, common chokecherry, lilac, American plum, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow-----	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
883*: Parnell	American plum	Common chokecherry, redosier dogwood, lilac, Siberian peashrub, eastern redcedar.	Siberian crabapple, Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
893. Harriet					
926 Hecla	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
939*: Hecla	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
Hamar	American plum	Redosier dogwood, common chokecherry, Siberian peashrub, lilac.	Black Hills spruce, green ash, Siberian crabapple, eastern redcedar.	Golden willow	Eastern cottonwood.
987*: Heimdal	---	Eastern redcedar, lilac, American plum, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Emrick	---	Siberian peashrub, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
992*:					
Heimdal	---	Eastern redcedar, lilac, American plum, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Emrick	---	Siberian peashrub, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Esmond	Siberian peashrub	Green ash, ponderosa pine, Russian-olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm	---	---
998*:					
Heimdal	---	Eastern redcedar, lilac, American plum, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Esmond	Siberian peashrub	Green ash, ponderosa pine, Russian-olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm	---	---
1013 Kelvin	---	American plum, eastern redcedar, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce, Russian-olive.	---	---
1014. Kelvin					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1104*: Lanona	---	Common chokecherry, Siberian peashrub, eastern redcedar, American plum, silver buffaloberry, Siberian crabapple, lilac.	Green ash, bur oak, ponderosa pine, Russian-olive.	---	---
Swenoda	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
1140 Letcher	Silver buffaloberry, Siberian peashrub, Rocky Mountain juniper.	Eastern redcedar, Russian-olive, ponderosa pine, green ash, Siberian elm.	---	---	---
1182 Lohnes	---	Rocky Mountain juniper, ponderosa pine, eastern redcedar.	---	---	---
1206. Maddock					
1221*: Maddock	---	Silver buffaloberry, common chokecherry, Siberian peashrub, eastern redcedar, lilac, American plum, Siberian crabapple.	Bur oak, green ash, ponderosa pine, Russian-olive.	---	---
Hecla	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1269--- Marysland	---	Redosier dogwood, eastern redcedar, American plum, lilac, common chokecherry, Siberian peashrub.	Black Hills spruce, Siberian crabapple, green ash.	Golden willow-----	Eastern cottonwood.
1291--- Metigoshe	Silver buffaloberry, lilac, Siberian peashrub.	Green ash, Russian-olive, Rocky Mountain juniper, eastern redcedar, Siberian crabapple, common chokecherry.	Ponderosa pine----	---	---
1292. Metigoshe					
1300*: Miranda.					
Cavour---	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian-olive, eastern redcedar.	---	---	---
1426--- Parnell	American plum-----	Common chokecherry, redosier dogwood, lilac, Siberian peashrub, eastern redcedar.	Siberian crabapple, Black Hills spruce, green ash.	Golden willow-----	Eastern cottonwood.
1466. Pits, sand and gravel					
1523--- Renshaw	Silver buffaloberry, Siberian peashrub, lilac.	Green ash, eastern redcedar, Rocky Mountain juniper, Siberian crabapple, common chokecherry.	Ponderosa pine, Russian-olive.	---	---
1571, 1572--- Rolla	---	Russian-olive, common chokecherry, eastern redcedar, lilac, silver buffaloberry, Siberian peashrub, Peking cotoneaster.	Siberian elm, green ash, ponderosa pine, Siberian crabapple.	---	---
1687, 1691. Sioux					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1709. Southam					
1727--------- Stirum	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian-olive, eastern redcedar.	---	---	---
1780--------- Swenoda	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, redosier dogwood.	Black Hills spruce, green ash.	Golden willow-----	Eastern cottonwood.
1843--------- Towner	---	Lilac, eastern redcedar, Siberian peashrub, common chokecherry, Siberian crabapple, American plum, silver buffaloberry.	Ponderosa pine, green ash, Russian-olive, bur oak.	---	---
1859--------- Ulen	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, redosier dogwood.	Black Hills spruce, green ash.	Golden willow-----	Eastern cottonwood.
1871--------- Vallers	Siberian peashrub, silver buffaloberry.	---	Siberian elm, green ash, Russian-olive.	---	---
1978. Water					
2046--------- Wyndmere	---	Redosier dogwood, ponderosa pine, American plum, Siberian peashrub, eastern redcedar, Peking cotoneaster, common chokecherry.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
2059---------- Wyrene	---	Siberian peashrub, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.

* 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 map unit was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
17*:				
Aberdeen	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Nahon	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
64 Arveson	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
66 Arveson	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
76 Arvilla	Slight	Slight	Moderate: slope.	Slight.
118*:				
Barnes	Slight	Slight	Moderate: slope, small stones.	Slight.
Buse	Slight	Slight	Moderate: slope, small stones.	Slight.
120*:				
Barnes	Slight	Slight	Severe: slope.	Slight.
Buse	Slight	Slight	Severe: slope.	Slight.
135*:				
Barnes	Slight	Slight	Moderate: slope, small stones.	Slight.
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
137*:				
Barnes	Slight	Slight	Moderate: small stones.	Slight.
Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
167 Bearden	Moderate: wetness.	Moderate: wetness, percs slowly.	Moderate: wetness.	Slight.
169 Bearden	Severe: excess salt.	Severe: excess salt.	Severe: excess salt.	Slight.
268 Bottineau	Slight	Slight	Severe: slope.	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
271--Bottineau	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
314*:				
Buse	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Barnes	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
318*:				
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
389*:				
Cathay	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Larson	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
392*:				
Cavour	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
430*:				
Claire	Severe: slope.	Severe: slope.	Severe: slope.	Severe: too sandy.
Lohnes	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
450--Colvin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
451--Colvin	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.
452--Colvin	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.
453--Colvin	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
470*:				
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Barnes	Slight	Slight	Moderate: small stones.	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
501*:				
Dickey	Moderate: too sandy.	Moderate: too sandy.	Severe: slope.	Moderate: too sandy.
Esmond	Slight	Slight	Severe: slope.	Slight.
502*:				
Dickey	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too sandy, slope.
Esmond	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Maddock	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too sandy, slope.
510 Divide	Slight	Slight	Slight	Slight.
532 Eckman	Slight	Slight	Moderate: slope.	Slight.
548 Egeland	Slight	Slight	Moderate: slope.	Slight.
569 Embden	Slight	Slight	Slight	Slight.
601, 602 Eramosh	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
605*:				
Esmond	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Heimdal	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
607*:				
Esmond	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Heimdal	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
768 Gardena	Slight	Slight	Slight	Slight.
800 Glyndon	Slight	Slight	Slight	Slight.
846*:				
Great Bend	Slight	Slight	Slight	Slight.
Overly	Slight	Slight	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
863 Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
864 Hamerly	Severe: excess salt.	Severe: excess salt.	Severe: excess salt.	Slight.
883*: Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
893 Harriet	Severe: flooding, wetness, percs slowly.	Severe: wetness, excess sodium, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.
926 Hecla	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.
939*: Hecla	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.
Hamar	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
987*: Heimdal	Slight	Slight	Slight	Slight.
Emrick	Slight	Slight	Slight	Slight.
992*: Heimdal	Slight	Slight	Moderate: slope.	Slight.
Emrick	Slight	Slight	Moderate: slope.	Slight.
Esmond	Slight	Slight	Moderate: slope.	Slight.
998*: Heimdal	Slight	Slight	Severe: slope.	Slight.
Esmond	Slight	Slight	Severe: slope.	Slight.
1013 Kelvin	Slight	Slight	Severe: slope.	Slight.
1014 Kelvin	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
1104*:				
Lanona	Slight	Slight	Moderate: slope.	Slight.
Swenoda	Slight	Slight	Moderate: slope.	Slight.
1140 Letcher	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
1182 Lohnes	Slight	Slight	Moderate: slope.	Slight.
1206 Maddock	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too sandy, slope.
1221*:				
Maddock	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
Hecla	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
1269 Marysland	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
1291 Metigoshe	Slight	Slight	Severe: slope.	Slight.
1292 Metigoshe	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
1300*:				
Miranda	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Cavour	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
1426 Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1466. Pits, sand and gravel				
1523 Renshaw	Slight	Slight	Slight	Slight.
1571 Rolla	Moderate: too clayey.	Moderate: too clayey.	Moderate: slope, too clayey.	Moderate: too clayey.
1572 Rolla	Moderate: slope, too clayey.	Moderate: slope, too clayey.	Severe: slope.	Moderate: too clayey.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
1687--Sioux	Slight	Slight	Moderate: slope, small stones.	Slight.
1691--Sioux	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
1709--Southam	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1727--Stirum	Severe: wetness, excess sodium.	Severe: excess sodium.	Severe: wetness, excess sodium.	Moderate: wetness.
1780--Swenoda	Slight	Slight	Slight	Slight.
1843--Towner	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
1859--Ulen	Slight	Slight	Slight	Slight.
1871--Vallers	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.
1978. Water				
2046--Wyndmere	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight.
2059--Wyrene	Slight	Slight	Moderate: small stones.	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 map unit 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	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
17*:									
Aberdeen	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Fair.
Nahon	Poor	Poor	Poor	Very poor	Very poor	Very poor	Poor	Poor	Poor.
64 Arveson	Poor	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
66 Arveson	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
76 Arvilla	Fair	Good	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
118*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
120*:									
Barnes	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
135*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Cresbard	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Good.
137*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Hamerly	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
167 Bearden	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
169 Bearden	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair	Poor.
268 Bottineau	Fair	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
271 Bottineau	Poor	Fair	Good	Good	Very poor	Very poor	Fair	Very poor	Good.
314*:									
Buse	Poor	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Barnes	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
318*:									
Buse	Very poor	Very poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Barnes	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very 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	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
389*:									
Cathay	Fair	Good	Good	Poor	Poor	Very poor	Fair	Very poor	Fair.
Larson	Poor	Poor	Poor	Very poor	Poor	Very poor	Poor	Very poor	Very poor.
392*:									
Cavour	Poor	Poor	Poor	Very poor	Very poor	Very poor	Poor	Very poor	Poor.
Cresbard	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Good.
430*:									
Claire	Poor	Fair	Fair	Good	Very poor	Very poor	Fair	Very poor	Fair.
Lohnes	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
450, 451 Colvin	Poor	Fair	Fair	Fair	Good	Good	Poor	Good	Fair.
452 Colvin	Poor	Fair	Poor	Fair	Good	Good	Poor	Good	Poor.
453 Colvin	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
470*:									
Cresbard	Good	Fair	Good	Poor	Very poor	Very poor	Good	Very poor	Good.
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
501*:									
Dickey	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Esmond	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
502*:									
Dickey	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Esmond	Very poor	Very poor	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Maddock	Very poor	Very poor	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.
510 Divide	Fair	Fair	Good	Fair	Fair	Very poor	Fair	Poor	Fair.
532 Eckman	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
548 Egeland	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
569 Embden	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
601 Eramosh	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
602 Eramosh	Very poor	Very poor	Very poor	Very poor	Good	Good	Very poor	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	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
605*:									
Esmond	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Heimdal	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
607*:									
Esmond	Very poor	Very poor	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Heimdal	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
768--Gardena	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
800--Glyndon	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
846*:									
Great Bend	Good	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
Overly	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
863--Hamerly	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
864--Hamerly	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair	Fair.
883*:									
Hamerly	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Tonka	Poor	Fair	Fair	Poor	Good	Good	Poor	Good	Poor.
Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
893--Harriet	Poor	Poor	Fair	Very poor	Good	Good	Poor	Good	Poor.
926--Hecla	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
939*:									
Hecla	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Hamar	Poor	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair.
987*:									
Heimdal	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Emrick	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
992*:									
Heimdal	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Emrick	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Esmond	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
998*:									
Heimdal	Fair	Good	Good	Fair	Poor	Very poor	Good	Very 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	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
998*: Esmond	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
1013 Kelvin	Fair	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
1014 Kelvin	Poor	Fair	Good	Good	Very poor	Very poor	Fair	Very poor	Good.
1104*: Lanona	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Swenoda	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
1140 Letcher	Poor	Poor	Poor	Very poor	Very poor	Very poor	Poor	Very poor	Very poor.
1182 Lohnes	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
1206 Maddock	Very poor	Very poor	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.
1221*: Maddock	Fair	Good	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
Hecla	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
1269 Marysland	Poor	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
1291 Metigoshe	Fair	Good	Fair	Poor	Poor	Very poor	Fair	Very poor	Poor.
1292 Metigoshe	Poor	Fair	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
1300*: Miranda	Poor	Poor	Very poor	Very poor	Poor	Poor	Poor	Poor	Very poor.
Cavour	Poor	Poor	Poor	Very poor	Very poor	Very poor	Poor	Very poor	Poor.
1426 Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
1466. Pits, sand and gravel									
1523 Renshaw	Poor	Fair	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
1571 Rolla	Good	Good	Fair	Good	Poor	Very poor	Good	Very poor	Fair.
1572 Rolla	Poor	Good	Fair	Good	Poor	Very poor	Poor	Very 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	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
1687---------- Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
1691---------- Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
1709---------- Southam	Very poor	Very poor	Very poor	Very poor	Good	Good	Very poor	Good	Very poor.
1727---------- Stirum	Very poor	Very poor	Very poor	Fair	Good	Fair	Very poor	Fair	Poor.
1780---------- Swenoda	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
1843---------- Towner	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
1859---------- Ulen	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
1871---------- Vallers	Poor	Fair	Very poor	Very poor	Good	Good	Poor	Good	Very poor.
1978. Water									
2046---------- Wyndmere	Fair	Good	Good	Fair	Fair	Poor	Good	Poor	Fair.
2059---------- Wyrene	Fair	Good	Good	Fair	Fair	Very poor	Fair	Poor	Fair.

* 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 map unit was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
17*:					
Aberdeen	Severe: cutbanks cave.	Severe: shrink-swell.	Moderate: wetness.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Nahon	Severe: cutbanks cave.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
64 Arveson	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
66 Arveson	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.
76 Arvilla	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
118*, 120*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
Buse	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
135*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
Cresbard	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
137*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, low strength.
Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
167, 169 Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.
268 Bottineau	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.

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
271---------- Bottineau	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, low strength.
314*:					
Buse----------	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: shrink-swell, low strength, slope.
Barnes----------	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: shrink-swell, low strength, slope.
318*:					
Buse----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Barnes----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
389*:					
Cathay----------	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Larson----------	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
392*:					
Cavour----------	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Cresbard---------	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
430*:					
Claire----------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Lohnes----------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
450---------- Colvin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness, frost action.
451---------- Colvin	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.
452---------- Colvin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness.

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
453---------- Colvin	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.
470*:					
Cresbard---------	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Barnes----------	Slight----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, low strength.
501*:					
Dickey----------	Severe: cutbanks cave.	Slight----------	Moderate: shrink-swell.	Moderate: slope.	Slight.
Esmond----------	Slight----------	Slight----------	Slight----------	Moderate: slope.	Moderate: frost action.
502*:					
Dickey----------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Esmond----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Maddock----------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
510---------- Divide	Severe: cutbanks cave.	Slight----------	Moderate: wetness.	Slight----------	Moderate: frost action.
532---------- Eckman	Slight----------	Slight----------	Slight----------	Slight----------	Severe: frost action.
548---------- Egeland	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight.
569---------- Embden	Severe: cutbanks cave.	Slight----------	Moderate: wetness.	Slight----------	Moderate: frost action.
601, 602---------- Eramosh	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.
605*:					
Esmond----------	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.
Heimdal----------	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.

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
607*:					
Esmond	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Heimdal	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
768 Gardena	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.
800 Glyndon	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.
846*:					
Great Bend	Severe: cutbanks cave.	Slight	Slight	Slight	Severe: low strength, frost action.
Overly	Moderate: too clayey, wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.
863, 864 Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
883*:					
Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
Parnell	Severe: excess humus, ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
893 Harriet	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.
926 Hecla	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
939*:					
Hecla	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
Hamar	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
987*:					
Heimdal	Slight	Slight	Slight	Slight	Moderate: frost action.

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
987*:					
Emrick	Slight	Slight	Slight	Slight	Moderate: frost action.
992*:					
Heimdal	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
Emrick	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
Esmond	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
998*:					
Heimdal	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
Esmond	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
1013 Kelvin	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
1014 Kelvin	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
1104*:					
Lanona	Slight	Slight	Moderate: shrink-swell.	Slight	Moderate: frost action.
Swenoda	Moderate: wetness.	Slight	Moderate: wetness, shrink-swell.	Slight	Moderate: frost action.
1140 Letcher	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
1182 Lohnes	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
1206 Maddock	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1221*:					
Maddock	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
Hecla	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
1269 Marysland	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
1291 Metigoshe	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	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
1292--Metigoshe	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1300*: Miranda	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell, low strength, wetness.
Cavour	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
1426--Parnell	Severe: excess humus, ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
1466. Pits, sand and gravel					
1523--Renshaw	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
1571--Rolla	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
1572--Rolla	Moderate: too clayey, slope.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, slope.	Severe: shrink-swell, low strength.
1687--Sioux	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
1691--Sioux	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1709--Southam	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
1727--Stirum	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.
1780--Swenoda	Moderate: wetness.	Slight	Moderate: wetness, shrink-swell.	Slight	Moderate: frost action.
1843--Towner	Severe: cutbanks cave.	Slight	Moderate: wetness, shrink-swell.	Slight	Moderate: frost action.
1859--Ulen	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.

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
1871---------- Vallers	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
1978. Water					
2046---------- Wyndmere	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.
2059---------- Wyrene	Severe: cutbanks cave.	Slight----------	Moderate: wetness.	Slight----------	Moderate: frost action.

* 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," "good," and other terms. Absence of an entry indicates that the map unit was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
17*:					
Aberdeen	Severe: percs slowly.	Moderate: seepage.	Severe: wetness, too clayey, too sandy.	Moderate: wetness.	Poor: too clayey, excess sodium.
Nahon	Severe: percs slowly.	Slight	Severe: wetness, too clayey, excess sodium.	Moderate: wetness.	Poor: too clayey, hard to pack, excess sodium.
64 Arveson	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
66 Arveson	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
76 Arvilla	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
118*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Buse	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
120*:					
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Buse	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
135*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Cresbard	Severe: percs slowly.	Moderate: slope, wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
137*:					
Barnes	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.

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
137*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
167 Bearden	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
169 Bearden	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack.
268 Bottineau	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
271 Bottineau	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
314*:					
Buse	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
318*:					
Buse	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Barnes	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
389*:					
Cathay	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, excess sodium.	Severe: wetness.	Poor: excess sodium.
Larson	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, excess sodium.	Severe: wetness.	Poor: excess sodium.
392*:					
Cavour	Severe: percs slowly.	Moderate: slope.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
Cresbard	Severe: percs slowly.	Moderate: slope, wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
430*:					
Claire	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.

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
430*:					
Lohnes	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
450 Colvin	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
451 Colvin	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
452 Colvin	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
453 Colvin	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
470*:					
Cresbard	Severe: percs slowly.	Moderate: wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
Barnes	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
501*:					
Dickey	Severe: percs slowly, poor filter.	Severe: seepage.	Moderate: too clayey.	Severe: seepage.	Fair: too clayey.
Esmond	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
502*:					
Dickey	Severe: percs slowly, poor filter, slope.	Severe: seepage, slope.	Severe: slope.	Severe: seepage, slope.	Poor: slope.
Esmond	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Maddock	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
510 Divide	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
532 Eckman	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.

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
548 Egeland	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.
569 Embden	Moderate: wetness.	Severe: seepage.	Severe: seepage, wetness.	Severe: seepage.	Fair: too sandy.
601, 602 Eramosh	Severe: ponding.	Severe: excess humus, ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
605*: Esmond	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Heimdal	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
607*: Esmond	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Heimdal	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
768 Gardena	Moderate: wetness, percs slowly.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Good.
800 Glyndon	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Fair: too clayey, wetness.
846*: Great Bend	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey, thin layer.
Overly	Severe: percs slowly.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Poor: thin layer.
863, 864 Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
883*: Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.

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
893---------- Harriet	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
926---------- Hecla	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, seepage.
939*: Hecla----------	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, seepage.
Hamar----------	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
987*: Heimdal----------	Moderate: percs slowly.	Moderate: seepage.	Slight----------	Slight----------	Good.
Emrick----------	Moderate: percs slowly.	Moderate: seepage.	Slight----------	Slight----------	Good.
992*: Heimdal----------	Moderate: percs slowly.	Moderate: seepage, slope.	Slight----------	Slight----------	Good.
Emrick----------	Moderate: percs slowly.	Moderate: seepage, slope.	Slight----------	Slight----------	Good.
Esmond----------	Moderate: percs slowly.	Moderate: seepage, slope.	Slight----------	Slight----------	Good.
998*: Heimdal----------	Moderate: percs slowly.	Severe: slope.	Slight----------	Slight----------	Good.
Esmond----------	Moderate: percs slowly.	Severe: slope.	Slight----------	Slight----------	Good.
1013---------- Kelvin	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight----------	Poor: too clayey, hard to pack.
1014---------- Kelvin	Severe: percs slowly, slope.	Severe: slope.	Severe: slope, too clayey.	Severe: slope.	Poor: too clayey, hard to pack, slope.
1104*: Lanona----------	Severe: percs slowly.	Severe: seepage.	Moderate: too clayey.	Severe: seepage.	Fair: too clayey.

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
1104*:					
Swenoda	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
1140--- Letcher	Severe: wetness.	Severe: seepage.	Severe: seepage, excess sodium.	Severe: seepage.	Poor: excess sodium.
1182--- Lohnes	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
1206--- Maddock	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
1221*:					
Maddock	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Hecla	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, seepage.
1269--- Marysland	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
1291--- Metigoshe	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
1292--- Metigoshe	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
1300*:					
Miranda	Severe: wetness, percs slowly.	Slight	Severe: wetness, excess sodium.	Severe: wetness.	Poor: excess sodium.
Cavour	Severe: percs slowly.	Slight	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
1426--- Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
1466. Pits, sand and gravel					

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
1523---------- Renshaw	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
1571---------- Rolla	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight----------	Poor: too clayey, hard to pack.
1572---------- Rolla	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey, hard to pack.
1687---------- Sioux	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
1691---------- Sioux	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
1709---------- Southam	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
1727---------- Stirum	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Poor: wetness, excess sodium.
1780---------- Swenoda	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
1843---------- Towner	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
1859---------- Ulen	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
1871---------- Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
1978. Water					
2046---------- Wyndmere	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: 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
2059---------- Wyrene	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.

* 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," and other terms. Absence of an entry indicates that the map unit was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
17*:				
Aberdeen	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess sodium.
Nahon	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium, excess salt.
64, 66 Arveson	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness.
76 Arvilla	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
118*, 120*:				
Barnes	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
Buse	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
135*:				
Barnes	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
Cresbard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess sodium.
137*:				
Barnes	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
167 Bearden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
169 Bearden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.
268 Bottineau	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
271 Bottineau	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
314*: Buse	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
Barnes	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
318*: Buse	Fair: shrink-swell, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Barnes	Fair: shrink-swell, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
389*: Cathay	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Larson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, excess sodium.
392*: Cavour	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess salt, excess sodium.
Cresbard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess sodium.
430*: Claire	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
Lohnes	Good	Probable	Improbable: too sandy.	Poor: too sandy.
450, 451 Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
452 Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
453---------- Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
470*:				
Cresbard----------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess sodium.
Barnes----------	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
501*:				
Dickey----------	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy.
Esmond----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
502*:				
Dickey----------	Fair: shrink-swell, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy, slope.
Esmond----------	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Maddock----------	Fair: slope.	Probable----------	Improbable: too sandy.	Poor: too sandy, slope.
510---------- Divide	Fair: wetness.	Probable----------	Probable----------	Poor: too sandy, small stones, area reclaim.
532---------- Eckman	Good----------	Improbable: excess fines.	Improbable: excess fines.	Good.
548---------- Egeland	Good----------	Probable----------	Improbable: too sandy.	Fair: small stones.
569---------- Embden	Good----------	Improbable: excess fines.	Improbable: excess fines.	Good.
601, 602---------- Eramosh	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
605*:				
Esmond----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Heimdal----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
607*:				
Esmond	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Heimdal	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
768 Gardena	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
800 Glyndon	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
846*:				
Great Bend	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Overly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
863 Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
864 Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.
883*:				
Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Parnell	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
893 Harriet	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess salt, wetness.
926 Hecla	Good	Probable	Improbable: too sandy.	Poor: too sandy.
939*:				
Hecla	Good	Probable	Improbable: too sandy.	Poor: too sandy.
Hamar	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, wetness.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
987*:				
Heimdal	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Emrick	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
992*:				
Heimdal	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Emrick	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Esmond	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
998*:				
Heimdal	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Esmond	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
1013--- Kelvin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
1014--- Kelvin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, slope.
1104*:				
Lanona	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Swenoda	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
1140--- Letcher	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
1182--- Lohnes	Good	Probable	Improbable: too sandy.	Poor: too sandy.
1206--- Maddock	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
1221*:				
Maddock	Good	Probable	Improbable: too sandy.	Poor: too sandy.
Hecla	Good	Probable	Improbable: too sandy.	Poor: too sandy.
1269--- Marysland	Poor: wetness.	Probable	Probable	Poor: wetness.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1291--- Metigoshe	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
1292--- Metigoshe	Fair: slope.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
1300*:				
Miranda---	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, excess sodium.
Cavour---	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess salt, excess sodium.
1426--- Parnell	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
1466. Pits, sand and gravel				
1523--- Renshaw	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
1571, 1572--- Rolla	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
1687--- Sioux	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
1691--- Sioux	Fair: slope.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
1709--- Southam	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
1727--- Stirum	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, excess sodium.
1780--- Swenoda	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1843--Towner	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy.
1859--Ulen	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
1871--Vallers	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
1978. Water				
2046--Wyndmere	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
2059--Wyrene	Good	Probable	Probable	Poor: small stones.

* 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 map unit was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
17*:						
Aberdeen	Moderate: seepage.	Severe: piping, excess sodium.	Deep to water	Percs slowly, excess sodium.	Erodes easily, percs slowly.	Excess sodium, erodes easily, percs slowly.
Nahon	Slight	Severe: hard to pack, excess sodium.	Deep to water	Percs slowly, excess sodium, excess salt.	Percs slowly, erodes easily.	Excess sodium, percs slowly, erodes easily.
64--Arveson	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Wetness.
66--Arveson	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, frost action, cutbanks cave.	Ponding	Ponding, too sandy.	Wetness.
76--Arvilla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
118*, 120*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Buse	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
135*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Cresbard	Moderate: slope.	Severe: excess sodium.	Deep to water	Slope, percs slowly, excess sodium.	Favorable	Excess sodium, percs slowly.
137*:						
Barnes	Slight	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Hamerly	Slight	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
167--Bearden	Moderate: seepage.	Moderate: piping, hard to pack, wetness.	Percs slowly, frost action.	Wetness	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.
169--Bearden	Moderate: seepage.	Moderate: piping, hard to pack, wetness.	Percs slowly, frost action, excess salt.	Wetness, percs slowly, rooting depth.	Wetness, percs slowly.	Excess salt, rooting depth, percs slowly.

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
268---------- Bottineau	Moderate: seepage, slope.	Slight---------	Deep to water	Slope----------	Erodes easily	Erodes easily.
271---------- Bottineau	Severe: slope.	Slight---------	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
314*, 318*:						
Buse----------	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
Barnes----------	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
389*:						
Cathay----------	Moderate: seepage, slope.	Severe: piping, excess sodium.	Deep to water	Slope, percs slowly.	Favorable------	Excess sodium, percs slowly.
Larson----------	Moderate: seepage, slope.	Severe: piping, excess sodium.	Deep to water	Slope, percs slowly.	Favorable------	Excess sodium, percs slowly.
392*:						
Cavour----------	Moderate: slope.	Severe: excess sodium.	Deep to water	Slope, percs slowly, rooting depth.	Erodes easily, percs slowly.	Excess sodium, erodes easily, rooting depth.
Cresbard---------	Moderate: slope.	Severe: excess sodium.	Deep to water	Slope, percs slowly, excess sodium.	Favorable------	Excess sodium, percs slowly.
430*:						
Claire----------	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
Lohnes----------	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
450---------- Colvin	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
451---------- Colvin	Moderate: seepage.	Severe: wetness.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
452---------- Colvin	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, excess salt, percs slowly.
453---------- Colvin	Moderate: seepage.	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
470*:						
Cresbard---------	Slight---------	Severe: excess sodium.	Deep to water	Percs slowly, excess sodium.	Favorable------	Excess sodium, percs slowly.

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
470*:						
Barnes	Slight	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
501*:						
Dickey	Severe: seepage.	Severe: piping.	Deep to water	Slope, droughty, fast intake.	Erodes easily, soil blowing.	Erodes easily, droughty.
Esmond	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
502*:						
Dickey	Severe: seepage, slope.	Severe: piping.	Deep to water	Slope, droughty, fast intake.	Slope, erodes easily, soil blowing.	Slope, erodes easily, droughty.
Esmond	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Maddock	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
510 Divide	Severe: seepage.	Severe: seepage.	Cutbanks cave	Wetness	Wetness, too sandy.	Favorable.
532 Eckman	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
548 Egeland	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty.	Too sandy, soil blowing.	Droughty.
569 Embden	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing	Soil blowing	Favorable.
601, 602 Eramosh	Moderate: seepage.	Severe: ponding.	Ponding, frost action.	Ponding	Erodes easily, ponding.	Wetness, erodes easily.
605*, 607*:						
Esmond	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Heimdal	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
768 Gardena	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
800 Glyndon	Severe: seepage.	Severe: piping.	Frost action	Wetness	Wetness	Favorable.
846*:						
Great Bend	Moderate: seepage.	Severe: piping.	Deep to water	Percs slowly	Erodes easily	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
846*:						
Overly	Slight	Severe: piping.	Deep to water	Percs slowly	Favorable	Percs slowly.
863 Hamerly	Slight	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
864 Hamerly	Slight	Severe: piping.	Frost action, excess salt.	Wetness, excess salt.	Erodes easily, wetness.	Excess salt, erodes easily.
883*:						
Hamerly	Slight	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
Parnell	Moderate: seepage.	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
893 Harriet	Slight	Severe: piping, wetness, excess sodium.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Erodes easily, wetness.	Wetness, excess sodium, erodes easily.
926 Hecla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
939*:						
Hecla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
Hamar	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Wetness, droughty.
987*:						
Heimdal	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Emrick	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
992*:						
Heimdal	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Emrick	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Esmond	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	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
998*:						
Heimdal	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Esmond	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
1013 Kelvin	Moderate: slope.	Moderate: hard to pack.	Deep to water	Slope	Erodes easily	Erodes easily.
1014 Kelvin	Severe: slope.	Moderate: hard to pack.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
1104*:						
Lanona	Severe: seepage.	Severe: piping.	Deep to water	Slope, soil blowing.	Soil blowing	Favorable.
Swenoda	Severe: seepage.	Severe: piping.	Favorable	Wetness, soil blowing.	Erodes easily, wetness.	Erodes easily.
1140 Letcher	Severe: seepage.	Severe: piping, excess sodium.	Deep to water	Slope, percs slowly.	Soil blowing	Excess sodium, percs slowly.
1182 Lohnes	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
1206 Maddock	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
1221*:						
Maddock	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
Hecla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
1269 Marysland	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Wetness.
1291 Metigoshe	Severe: seepage.	Severe: seepage.	Deep to water	Slope, droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
1292 Metigoshe	Severe: seepage, slope.	Severe: seepage.	Deep to water	Slope, droughty, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
1300*:						
Miranda	Slight	Severe: piping, excess sodium.	Percs slowly, excess salt.	Wetness, percs slowly.	Wetness, percs slowly.	Excess sodium, percs slowly.

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
1300*: Cavour	Slight	Severe: excess sodium.	Deep to water	Percs slowly, rooting depth.	Erodes easily, percs slowly.	Excess sodium, erodes easily, rooting depth.
1426 Parnell	Moderate: seepage.	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
1466. Pits, sand and gravel						
1523 Renshaw	Severe: seepage.	Severe: seepage.	Deep to water	Droughty	Too sandy	Droughty.
1571 Rolla	Moderate: slope.	Severe: hard to pack.	Deep to water	Slope, slow intake, percs slowly.	Percs slowly	Percs slowly.
1572 Rolla	Severe: slope.	Severe: hard to pack.	Deep to water	Slope, slow intake, percs slowly.	Slope, percs slowly.	Slope, percs slowly.
1687 Sioux	Severe: seepage.	Severe: seepage.	Deep to water	Slope, droughty.	Too sandy	Droughty.
1691 Sioux	Severe: seepage, slope.	Severe: seepage.	Deep to water	Slope, droughty.	Slope, too sandy.	Slope, droughty.
1709 Southam	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, excess salt, erodes easily.
1727 Stirum	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave, excess salt.	Wetness, droughty.	Wetness, too sandy, soil blowing.	Wetness, excess salt, excess sodium.
1780 Swenoda	Severe: seepage.	Severe: piping.	Favorable	Wetness, soil blowing.	Erodes easily, wetness.	Erodes easily.
1843 Towner	Severe: seepage.	Severe: piping.	Deep to water	Slope, droughty, fast intake.	Erodes easily, soil blowing.	Erodes easily, droughty.
1859 Ulen	Severe: seepage.	Severe: seepage, piping.	Cutbanks cave	Wetness, droughty.	Wetness, too sandy, soil blowing.	Droughty.
1871 Vallers	Slight	Severe: piping, wetness.	Frost action, excess salt.	Wetness, excess salt.	Wetness	Wetness, excess salt.
1978. Water						
2046 Wyndmere	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Favorable.

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
2059---------- Wyrene	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.

* 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	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
17*:											
Aberdeen	0-10	Silt loam, silty clay loam.	CL, ML	A-6, A-7, A-4	0	100	100	95-100	90-100	30-45	7-20
	10-18	Silty clay, clay, silty clay loam.	ML, MH	A-7	0	100	100	95-100	90-100	45-75	15-40
	18-42	Silty clay loam, silt loam.	CL, CH, MH, ML	A-6, A-7, A-4	0	100	100	95-100	90-100	30-55	7-25
	42-60	Silt loam, silty clay loam.	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	95-100	85-100	25-50	5-25
Nahon	0-7	Silt loam	CL, ML	A-6, A-7	0	100	100	90-100	80-100	30-45	5-20
	7-9	Silty clay loam, silt loam.	CL, ML	A-6, A-7	0	100	100	95-100	90-100	35-50	10-25
	9-17	Silty clay, silty clay loam.	MH, CH, CL, ML	A-7	0	100	100	95-100	90-100	45-65	15-35
	17-41	Silty clay, silty clay loam, silt loam.	CL, CH, MH, ML	A-7, A-6	0	100	100	90-100	80-100	30-65	10-30
	41-60	Silt loam, silty clay loam, silty clay.	CL, CH, ML, MH	A-7	0	100	100	90-100	75-100	40-70	15-35
64	0-16	Loam	ML	A-4	0-1	100	95-100	85-90	50-80	20-40	NP-10
Arveson	16-26	Fine sandy loam, sandy loam, loam.	SM, SC-SM	A-4	0	100	95-100	60-85	35-50	<20	NP-5
	26-60	Fine sand, loamy fine sand.	SP-SM, SM, SC-SM	A-3, A-2, A-4	0	100	95-100	50-85	5-50	<20	NP-5
66	0-16	Loam	ML	A-4	0	100	95-100	85-90	50-80	20-40	NP-10
Arveson	16-26	Fine sandy loam, sandy loam, loam.	SM, SC-SM	A-4	0	100	95-100	60-85	35-50	<20	NP-5
	26-60	Fine sand, loamy sand, fine sandy loam.	SP-SM, SM, SC-SM	A-3, A-2, A-4	0	100	95-100	50-85	5-50	<20	NP-5
76	0-10	Sandy loam	SM, SC, SC-SM	A-2, A-4, A-6	0	95-100	90-100	50-80	20-45	<30	NP-15
Arvilla	10-16	Sandy loam, loam, coarse sandy loam.	SM, SC, SC-SM	A-2, A-4, A-6	0	90-100	85-100	50-80	20-45	<40	NP-15
	16-60	Gravelly coarse sand, coarse sand, very gravelly coarse sand.	SP-SM, GP, SM, GP-GM	A-1, A-2, A-3	0	35-100	25-100	10-60	0-15	---	NP
118*, 120*:											
Barnes	0-6	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	6-18	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	18-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Buse	0-7	Loam	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-35	3-15
	7-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
135*:											
Barnes	0-6	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	6-18	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	18-42	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	42-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Cresbard	0-9	Loam	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	9-27	Clay loam, silty clay, clay.	CL, CH	A-7, A-6	0	95-100	90-100	85-100	65-85	30-60	15-30
	27-44	Clay loam, silty clay, loam.	CL, CH	A-7	0	95-100	90-100	85-100	65-85	40-60	15-30
	44-60	Clay loam, loam	CL, CH	A-6, A-7	0-5	95-100	90-100	85-100	50-80	25-55	10-27
137*:											
Barnes	0-6	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	6-18	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	18-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Hamerly	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
	7-29	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	29-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	55-75	20-45	5-25
167	0-11	Silt loam	CL-ML, CL	A-4, A-6	0	100	100	90-100	70-90	20-40	5-20
Bearden	11-31	Silt loam, silty clay loam.	CL, CH	A-6, A-7	0	100	100	90-100	80-95	25-55	10-30
	31-60	Silt loam, silty clay loam.	CL, CH	A-6, A-7	0	100	100	90-100	80-95	25-55	10-30
169	0-11	Silt loam	CL-ML, CL	A-4, A-6	0	100	100	90-100	70-90	20-40	5-20
Bearden	11-31	Silt loam, silty clay loam.	CL, CH	A-6, A-7, A-4	0	100	100	95-100	80-95	25-55	7-30
	31-60	Silt loam, silty clay loam.	CL, CH	A-6, A-7, A-4	0	100	100	95-100	80-95	25-55	7-30
268, 271	0-7	Loam	CL	A-6, A-7	0-5	95-100	90-100	85-95	60-75	25-45	15-25
Bottineau	7-25	Clay loam, loam	CL	A-6, A-7	0-5	95-100	90-100	80-100	65-85	35-50	15-25
	25-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	90-100	80-100	65-85	35-50	15-25
314*, 318*:											
Buse	0-7	Loam	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-35	3-15
	7-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20
Barnes	0-6	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	6-18	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	18-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
389*:											
Cathay	0-9	Loam	ML, CL, CL-ML	A-4	0-5	95-100	90-100	75-95	50-95	25-35	5-10
	9-31	Clay loam, loam	CL	A-6	0-5	95-100	90-100	85-95	60-85	25-40	10-25
	31-60	Loam	ML, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-75	25-40	3-25
Larson	0-12	Loam, fine sandy loam.	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	75-100	50-90	15-40	5-20
	12-23	Loam, clay loam	CL	A-6, A-7	0-5	95-100	85-100	75-100	60-80	30-45	10-30
	23-60	Loam, clay loam, silt loam.	CL, CL-ML	A-6, A-4, A-7	0-5	95-100	85-100	75-100	50-90	15-45	5-25

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
392*:											
Cavour	0-7	Loam	ML, MH	A-4, A-6, A-7	0	100	90-100	85-100	60-85	30-55	5-20
	7-39	Loam, clay loam	CL, CH, MH, ML	A-7, A-6	0	100	90-100	90-100	55-85	35-65	15-30
	39-60	Clay loam, loam	CL, CH	A-7, A-6	0-5	95-100	90-100	75-100	50-85	35-65	12-35
Cresbard	0-9	Loam	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	9-27	Clay loam, silty clay, clay.	CL, CH	A-7, A-6	0	95-100	90-100	85-100	65-85	30-60	15-30
	27-44	Clay loam, silty clay, loam.	CL, CH	A-7	0	95-100	90-100	85-100	65-85	40-60	15-30
	44-60	Clay loam, loam	CL, CH	A-6, A-7	0-5	95-100	90-100	85-100	50-80	25-55	10-27
430*:											
Claire	0-4	Coarse sand	SP-SM, SM	A-1, A-2-4, A-3	0	95-100	95-100	30-75	5-15	<20	NP
	4-32	Coarse sand, loamy coarse sand.	SM, SP-SM	A-1, A-2-4, A-3	0	95-100	95-100	30-75	5-15	<20	NP
	32-60	Fine sand, sand, coarse sand.	SM, SP-SM	A-1, A-3, A-2-4	0	95-100	95-100	30-80	5-35	<20	NP
Lohnes	0-14	Loamy sand	SM, SP-SM	A-2, A-1	0	100	100	45-65	10-25	---	NP
	14-20	Coarse sand, loamy coarse sand, loamy sand.	SM, SP-SM, SP	A-2, A-1, A-3	0	95-100	95-100	35-60	2-20	---	NP
	20-60	Coarse sand, loamy coarse sand, loamy sand.	SM, SP-SM, SP	A-2, A-1, A-3	0	95-100	95-100	35-60	2-20	---	NP
450, 451 Colvin	0-12	Silt loam	CL	A-6	0	100	100	90-100	80-95	25-40	10-20
	12-33	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
	33-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	25-50	10-25
452 Colvin	0-12	Silt loam	CL	A-6	0	100	100	90-100	80-95	20-35	10-20
	12-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	20-50	10-30
453 Colvin	0-12	Silt loam	CL	A-6	0	100	100	90-100	80-95	25-40	10-20
	12-33	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
	33-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	25-50	10-25
470*:											
Cresbard	0-9	Loam	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	9-27	Clay loam, silty clay, clay.	CL, CH	A-7, A-6	0	95-100	90-100	85-100	65-85	30-60	15-30
	27-44	Clay loam, silty clay, loam.	CL, CH	A-7	0	95-100	90-100	85-100	65-85	40-60	15-30
	44-60	Clay loam, loam	CL, CH	A-6, A-7	0-5	95-100	90-100	85-100	50-80	25-55	10-27

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
470*:											
Barnes	0-6	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	6-18	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	18-42	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	42-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
501*:											
Dickey	0-5	Loamy fine sand	SM	A-2-4	0	100	100	50-75	15-30	---	NP
	5-32	Loamy fine sand, loamy sand, fine sand.	SM	A-2-4	0	100	100	50-80	15-35	---	NP
	32-60	Loam, clay loam, silty clay loam.	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-100	60-90	24-40	4-20
Esmond	0-7	Loam	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	7-60	Loam, sandy loam, fine sandy loam.	ML, SM, SC, CL	A-4, A-6	0-5	90-100	85-100	60-100	35-90	20-40	NP-15
502*:											
Dickey	0-5	Loamy fine sand	SM	A-2-4	0	100	100	50-75	15-30	---	NP
	5-32	Loamy fine sand, loamy sand, fine sand.	SM	A-2-4	0	100	100	50-80	15-35	---	NP
	32-60	Loam, clay loam, silty clay loam.	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-100	60-90	24-40	4-20
Esmond	0-7	Loam	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	7-60	Loam, sandy loam, fine sandy loam.	ML, SM, SC, CL	A-4, A-6	0-5	90-100	85-100	60-100	35-90	20-40	NP-15
Maddock	0-6	Loamy fine sand	SM	A-2	0	100	100	50-80	15-35	---	NP
	6-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	60-100	5-35	---	NP
510	0-8	Loam	CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-85	25-40	5-20
Divide	8-25	Loam, clay loam, gravelly loam.	CL, CL-ML, SC-SM, SC	A-4, A-6, A-7	0-3	95-100	75-100	55-90	35-80	20-45	5-20
	25-60	Stratified sand to gravelly coarse sand.	GM, SM, GP-GM, SP-SM	A-1, A-3	0-5	25-100	15-100	10-70	5-25	<30	NP-5
532	0-11	Silt loam	ML	A-4	0	100	100	85-100	60-90	20-40	NP-10
Eckman	11-32	Silt loam, very fine sandy loam.	ML	A-4	0	100	100	85-100	55-95	20-40	NP-10
	32-60	Silt loam, very fine sandy loam, loamy very fine sand.	ML, SM	A-4	0	100	100	65-100	40-90	<40	NP-10
548	0-8	Fine sandy loam	SM, SC-SM	A-2, A-4	0	100	95-100	75-100	30-50	<30	NP-7
Egeland	8-15	Sandy loam, fine sandy loam.	SM, SC-SM	A-2, A-4	0	95-100	85-100	70-100	15-50	<30	NP-7
	15-60	Loamy fine sand, fine sandy loam.	SM, SP-SM, SC-SM	A-2, A-4	0	95-100	85-100	70-100	10-45	<25	NP-5
569	0-16	Fine sandy loam	SM, ML	A-2, A-4	0	100	100	60-95	30-75	<35	NP-10
Embden	16-27	Fine sandy loam, sandy loam.	SM, ML	A-2, A-4	0	100	100	60-100	25-55	---	NP
	27-60	Fine sandy loam, sandy loam, loamy fine sand.	SM	A-2, A-4	0	100	100	50-100	15-50	---	NP

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
601, 602---	0-15	Peat, mucky peat	PT	A-8	0	---	---	---	---	---	---
Eramosh	15-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
605*, 607*:											
Esmond---	0-7	Loam---	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	7-60	Loam, sandy loam, fine sandy loam.	ML, SM, SC, CL	A-4, A-6	0-5	90-100	85-100	60-100	35-90	20-40	NP-15
Heimdal---	0-8	Loam---	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	8-17	Loam---	ML, CL	A-4, A-6	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	17-60	Loam, sandy loam	ML, SM, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	60-100	35-90	20-40	NP-15
768---	0-16	Silt loam---	ML, CL	A-4, A-6	0	100	100	75-100	60-100	25-40	NP-15
Gardena	16-60	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4, A-6	0	100	100	75-100	55-100	20-40	NP-15
800---	0-7	Silt loam---	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
Glyndon	7-29	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	60-95	20-30	NP-10
	29-60	Loam, silt loam	ML, CL, CL-ML	A-4	0	100	100	90-100	60-95	20-30	NP-10
846*:											
Great Bend---	0-8	Silt loam---	CL, ML	A-4, A-6, A-7	0	100	100	95-100	90-100	30-45	5-20
	8-13	Silt loam, silty clay loam.	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
	13-26	Silt loam, silty clay loam.	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
	26-60	Silt loam, silty clay loam.	CL, ML, CL-ML	A-4, A-6, A-7	0	100	100	95-100	85-100	25-50	5-25
Overly---	0-14	Silt loam---	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	85-100	25-45	5-25
	14-28	Silty clay loam, silt loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
	28-60	Silt loam, silty clay, silty clay loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
863---	0-7	Loam---	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
Hamerly	7-29	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	29-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	55-75	20-45	5-25
864---	0-7	Loam---	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	25-40	5-20
Hamerly	7-29	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	25-45	5-20
	29-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	25-45	5-20
883*:											
Hamerly---	0-7	Loam---	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
	7-29	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	29-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	55-75	20-45	5-25

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
883*:											
Tonka	0-14	Silt loam, loam	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-35	5-15
	14-34	Silty clay loam, clay loam, clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	34-60	Clay loam, loam	CL, CL-ML	A-6, A-7, A-4	0-3	90-100	85-100	60-100	50-90	25-50	5-30
Parnell	0-11	Silt loam	OL, ML	A-4	0	100	100	90-100	70-90	25-40	2-10
	11-37	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	37-60	Clay loam, silty clay loam, loam.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
893	0-2	Silt loam	CL, CL-ML	A-4, A-6	0	100	100	85-100	60-90	25-40	5-20
Harriet	2-24	Clay loam, silty clay loam, silty clay.	CL, CH	A-7, A-6	0	100	100	90-100	70-100	35-70	20-40
	24-60	Silty clay loam, silty clay.	CL, CL-ML, CH	A-4, A-6 A-7	0	100	100	90-100	60-100	20-65	5-40
926	0-6	Loamy fine sand	SM, SC-SM, SP-SM	A-2	0	100	95-100	85-100	12-35	<25	NP-7
Hecla	6-26	Loamy sand, loamy fine sand, fine sand.	SM, SC-SM, SP-SM	A-2	0	100	95-100	85-100	12-35	<25	NP-7
	26-60	Loamy sand, fine sand, loamy fine sand.	SM, SC-SM, SP-SM	A-2	0	100	95-100	85-100	10-35	<25	NP-7
939*:											
Hecla	0-6	Loamy fine sand	SM, SC-SM, SP-SM	A-2	0	100	95-100	85-100	12-35	<25	NP-7
	6-26	Loamy sand, loamy fine sand, fine sand.	SM, SC-SM, SP-SM	A-2	0	100	95-100	85-100	12-35	<25	NP-7
	26-60	Loamy sand, fine sand, loamy fine sand.	SM, SC-SM, SP-SM	A-2	0	100	95-100	85-100	10-35	<25	NP-7
Hamar	0-12	Loamy fine sand	SM, SC-SM	A-2, A-4	0	100	100	85-100	15-40	<25	NP-5
	12-17	Loamy fine sand, loamy sand, fine sand.	SM, SC-SM, SP-SM	A-2, A-4	0	100	100	70-100	10-40	<25	NP-5
	17-60	Fine sand, loamy sand, loamy fine sand.	SM, SC-SM, SP-SM	A-2	0	100	100	70-100	10-35	<25	NP-5
987*:											
Heimdal	0-8	Loam	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	8-17	Loam	ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	17-60	Loam, sandy loam	ML, SM, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	60-100	35-90	20-40	NP-15
Emrick	0-7	Loam	ML	A-4	0-1	95-100	95-100	85-100	60-90	<40	NP-10
	7-33	Loam	ML	A-4	0-1	95-100	95-100	85-95	55-75	<40	NP-10
	33-60	Loam, sandy loam	ML, SM, SC	A-4, A-6	0-5	90-100	90-100	60-100	35-90	<40	NP-10

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
992*:											
Heimdal	0-8	Loam	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	8-17	Loam	ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	17-60	Loam, sandy loam	ML, SM, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	60-100	35-90	20-40	NP-15
Emrick	0-7	Loam	ML	A-4	0-1	95-100	95-100	85-100	60-90	<40	NP-10
	7-33	Loam	ML	A-4	0-1	95-100	95-100	85-95	55-75	<40	NP-10
	33-60	Loam, sandy loam	ML, SM, SC	A-4, A-6	0-5	90-100	90-100	60-100	35-90	<40	NP-10
Esmond	0-7	Loam	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	7-60	Loam, sandy loam, fine sandy loam.	ML, SM, SC, CL	A-4, A-6	0-5	90-100	85-100	60-100	35-90	20-40	NP-15
998*:											
Heimdal	0-8	Loam	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	8-17	Loam	ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	17-60	Loam, sandy loam	ML, SM, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	60-100	35-90	20-40	NP-15
Esmond	0-7	Loam	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	7-60	Loam, sandy loam, fine sandy loam.	ML, SM, SC, CL	A-4, A-6	0-5	90-100	85-100	60-100	35-90	20-40	NP-15
1013, 1014 Kelvin	0-4	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-75	20-40	5-15
	4-23	Clay loam, clay	CL, CH	A-7, A-6	0-5	95-100	90-100	90-100	70-90	35-60	20-35
	23-60	Loam, clay loam	CL, ML	A-6, A-7	0-5	95-100	90-100	75-100	50-80	30-50	10-30
1104*:											
Lanona	0-9	Fine sandy loam	SM, SC, SC-SM	A-2, A-4	0	100	95-100	70-100	30-50	20-30	NP-10
	9-29	Fine sandy loam, sandy loam.	SM, SC-SM, SC	A-2, A-4	0	100	95-100	60-100	30-50	20-30	NP-10
	29-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-100	50-95	25-45	5-20
Swenoda	0-12	Fine sandy loam	SM	A-2, A-4	0	100	95-100	70-100	30-50	20-30	NP-7
	12-28	Fine sandy loam, sandy loam, loamy fine sand.	SC-SM, SM, ML, CL-ML	A-2, A-4	0	100	95-100	60-100	30-60	15-30	NP-10
	28-60	Silt loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6, A-7	0-5	90-100	90-100	75-100	50-95	20-50	5-30
1140 Letcher	0-8	Fine sandy loam	SM, SC-SM	A-4	0	100	100	60-95	35-50	15-30	NP-7
	8-13	Sandy loam, fine sandy loam, loamy fine sand.	SM, SC-SM	A-2, A-4	0	100	100	60-100	20-45	15-30	NP-7
	13-24	Sandy loam, fine sandy loam.	SM, SC, ML, CL	A-4, A-6, A-2	0	100	100	60-100	30-60	20-40	3-18
	24-60	Sandy loam, fine sandy loam, loam.	SM, SC, ML, CL	A-2, A-4, A-6	0	100	95-100	50-100	30-60	20-40	3-18
1182 Lohnes	0-14	Loamy sand	SM, SP-SM	A-2, A-1	0	100	100	45-65	10-25	---	NP
	14-20	Coarse sand, loamy coarse sand, loamy sand.	SM, SP-SM, SP	A-2, A-1, A-3	0	95-100	95-100	35-60	2-20	---	NP
	20-60	Coarse sand, loamy coarse sand, loamy sand.	SM, SP-SM, SP	A-2, A-1, A-3	0	95-100	95-100	35-60	2-20	---	NP

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
1206	0-6	Loamy fine sand	SM	A-2	0	100	100	50-80	15-35	---	NP
	6-60	Sand, loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	60-100	5-35	---	NP
1221*:											
Maddock	0-6	Loamy fine sand	SM	A-2	0	100	100	50-80	15-35	---	NP
	6-60	Sand, loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	60-100	5-35	---	NP
Hecla	0-6	Loamy fine sand	SM, SC-SM, SP-SM	A-2	0	100	95-100	85-100	12-35	<25	NP-7
	6-26	Loamy sand, loamy fine sand, fine sand.	SM, SC-SM, SP-SM	A-2	0	100	95-100	85-100	12-35	<25	NP-7
	26-60	Loamy sand, fine sand, loamy fine sand.	SM, SC-SM, SP-SM	A-2	0	100	95-100	85-100	10-35	<25	NP-7
1269	0-18	Silt loam	CL	A-6, A-7	0	95-100	95-100	85-95	50-80	30-50	10-25
Marysland	18-32	Loam, clay loam, sandy clay loam.	CL, SC	A-6	0	90-100	85-100	80-95	45-80	20-40	10-20
	32-60	Coarse sand, gravelly coarse sand, sand.	SP-SM, SM	A-1, A-2, A-3	0	70-95	50-90	35-70	5-20	---	NP
1291, 1292	0-5	Sandy loam	SM, SC-SM	A-2, A-4	0-5	95-100	95-100	50-70	15-40	<25	NP-5
Metigoshe	5-15	Coarse sandy loam, sandy loam, loamy sand.	SM, SC-SM	A-2	0-5	95-100	95-100	60-70	20-30	<25	NP-5
	15-60	Gravelly coarse sand, gravelly sand.	SM, GP, SP, GM	A-1	0-5	35-95	25-80	10-50	0-15	---	NP
1300*:											
Miranda	0-2	Loam	CL-ML, CL, ML	A-4, A-6	0	100	100	85-95	60-85	20-40	3-15
	2-8	Loam, clay loam	CL	A-6, A-7	0-5	95-100	95-100	85-95	50-80	30-50	10-30
	8-60	Loam, clay loam	CL, ML, SM	A-6, A-7, A-4	0-5	90-100	90-100	60-95	30-80	20-50	NP-30
Cavour	0-7	Loam	ML, MH	A-4, A-6, A-7	0	100	90-100	85-100	60-85	30-55	5-20
	7-39	Loam, clay loam.	CL, CH, MH, ML	A-7, A-6	0	100	90-100	90-100	55-85	35-65	15-30
	39-60	Clay loam, loam.	CL, CH	A-7, A-6	0-5	95-100	90-100	75-100	50-85	35-65	12-35
1426	0-11	Silt loam	OL, ML	A-4	0	100	100	90-100	70-90	25-40	2-10
Parnell	11-37	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	37-60	Clay loam, silty clay loam, loam.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
1466. Pits, sand and gravel											

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
1523----------	0-6	Loam----------	ML	A-4	0-5	95-100	90-100	70-100	50-75	20-40	NP-10
Renshaw	6-16	Loam, sandy clay loam, gravelly loam.	SC-SM, SC, ML, CL	A-4, A-6	0-5	95-100	55-100	45-90	35-70	20-40	3-15
	16-60	Gravelly coarse sand, very gravelly loamy sand, gravelly sand.	SW, SM, SW-SM, GW-GM	A-1, A-2	0-5	45-95	30-80	10-60	0-15	<25	NP-5
1571, 1572-------	0-6	Silty clay-------	CH	A-7	0	100	100	95-100	90-100	55-70	30-45
Rolla	6-24	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	60-80	30-50
	24-60	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	60-80	30-50
1687, 1691-------	0-5	Loam----------	ML, CL	A-4, A-6	0-5	95-100	85-100	70-90	55-75	30-40	5-15
Sioux	5-9	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	9-60	Gravelly coarse sand, very gravelly loamy sand, very gravelly coarse sand.	GM, GP, SM, SP	A-1	0	25-75	20-60	5-35	0-25	<25	NP-5
1709----------	0-6	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	95-100	90-100	85-100	25-40	5-15
Southam	6-26	Silty clay, clay, silty clay loam.	CL, CH	A-7	0	100	95-100	90-100	85-100	40-75	15-50
	26-60	Clay loam, silty clay loam.	CL, CH, CL-ML	A-6, A-7, A-4	0	100	95-100	85-100	60-100	20-75	5-50
1727----------	0-7	Fine sandy loam, loamy fine sand	SM, ML, SC-SM, CL-ML	A-2, A-4	0	100	100	60-95	30-60	15-25	NP-5
Stirum	7-16	Loam, fine sandy loam.	SC, CL, ML, SM	A-2, A-4	0	100	100	60-95	30-75	15-30	NP-10
	16-60	Silt loam to loamy sand.	SM, CL, ML, SC	A-2, A-4, A-6	0	100	100	50-100	15-90	<30	NP-15
1780----------	0-12	Fine sandy loam	SM	A-2, A-4	0	100	95-100	70-100	30-50	20-30	NP-7
Swenoda	12-28	Fine sandy loam, sandy loam, loamy fine sand.	SC-SM, SM, ML, CL-ML	A-2, A-4	0	100	95-100	60-100	30-60	15-30	NP-10
	28-60	Silt loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6, A-7	0-5	90-100	90-100	75-100	50-95	20-50	5-30
1843----------	0-10	Loamy fine sand	SM, SC-SM	A-2	0	100	100	50-80	15-35	<25	NP-5
Towner	10-31	Loamy sand, loamy fine sand, fine sand.	SM, SC-SM, SW-SM, SP-SM	A-2, A-3	0	100	95-100	50-100	5-35	<25	NP-5
	31-60	Loam, silt loam, silty clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	85-100	55-100	25-50	5-30
1859----------	0-8	Fine sandy loam	SM, SC-SM, SC	A-4	0	100	100	80-100	35-50	<25	NP-8
Ulen	8-20	Loamy fine sand, fine sand.	SM	A-2	0	100	95-100	70-95	12-35	---	NP
	20-60	Fine sand, loamy fine sand, sand.	SP-SM, SM	A-3, A-2	0	100	95-100	80-100	5-35	---	NP

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
1871---------- Vallers	0-8	Loam----------	ML	A-4	0-5	95-100	90-100	80-90	65-80	25-40	3-10
	8-30	Clay loam, silty clay loam, loam.	CL	A-6	0-5	95-100	90-100	80-95	50-80	30-40	10-20
	30-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-75	20-40	5-20
1978. Water											
2046---------- Wyndmere	0-7	Fine sandy loam	SM, ML, SC, SC-SM	A-2, A-4	0	100	100	60-80	30-55	10-30	NP-10
	7-29	Sandy loam, fine sandy loam.	SM, ML, SC, SC-SM	A-2, A-4	0	100	100	60-90	30-55	10-30	NP-10
	29-60	Fine sand, loamy fine sand, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-100	20-55	---	NP
2059---------- Wyrene	0-24	Sandy loam-------	SC-SM, ML, SM, SC	A-2, A-4	0	85-100	80-100	60-90	25-65	10-30	NP-10
	24-60	Coarse sand, gravelly coarse sand.	SM, SP-SM	A-1, A-2, A-3	0-5	60-90	55-80	30-70	5-15	<20	NP

* 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" 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	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
17*:									
Aberdeen	0-10	0.6-2.0	0.19-0.22	5.6-7.3	<2	Moderate	0.32	3	6
	10-18	0.06-0.2	0.13-0.18	6.6-8.4	<4	High	0.32		
	18-42	0.06-2.0	0.14-0.17	7.4-9.0	2-8	High	0.43		
	42-60	0.06-2.0	0.14-0.17	7.4-9.0	2-8	Low	0.43		
Nahon	0-7	0.2-0.6	0.19-0.22	5.6-7.3	<2	Moderate	0.28	3	6
	7-9	0.2-0.6	0.19-0.22	5.6-7.3	<2	Moderate	0.28		
	9-17	<0.06	0.10-0.15	6.6-9.0	<2	High	0.28		
	17-41	0.06-0.2	0.11-0.19	7.4-9.0	4-16	High	0.28		
	41-60	<0.6	0.14-0.17	7.9-9.0	4-16	Moderate	0.43		
64, 66	0-16	2.0-6.0	0.16-0.18	7.4-8.4	<2	Low	0.24	4	4L
Arveson	16-26	0.6-2.0	0.15-0.17	7.4-8.4	<2	Low	0.24		
	26-60	2.0-20	0.05-0.15	7.4-8.4	<2	Low	0.17		
76	0-10	2.0-6.0	0.13-0.15	6.6-8.4	<2	Low	0.20	3	3
Arvilla	10-16	2.0-6.0	0.11-0.14	6.6-8.4	<2	Low	0.20		
	16-60	>20	0.02-0.05	7.4-8.4	<2	Low	0.10		
118*, 120*:									
Barnes	0-6	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low	0.28	5	6
	6-18	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	18-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Buse	0-7	0.2-0.6	0.17-0.22	6.6-8.4	<2	Low	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
135*:									
Barnes	0-6	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low	0.28	5	6
	6-18	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	18-42	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
	42-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
Cresbard	0-9	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low	0.32	3	6
	9-27	0.06-0.2	0.11-0.14	5.6-7.8	2-4	High	0.32		
	27-44	0.06-0.2	0.11-0.15	6.1-8.4	2-4	High	0.32		
	44-60	0.2-0.6	0.16-0.20	7.4-9.0	2-8	Moderate	0.32		
137*:									
Barnes	0-6	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low	0.28	5	6
	6-18	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	18-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Hamerly	0-7	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate	0.28	5	4L
	7-29	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	29-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
167	0-11	0.6-2.0	0.20-0.24	7.4-8.4	<4	Moderate	0.28	5	4L
Bearden	11-31	0.2-2.0	0.16-0.22	7.4-8.4	<4	Moderate	0.28		
	31-60	0.2-0.6	0.16-0.22	7.4-8.4	<4	Moderate	0.43		
169	0-11	0.6-2.0	0.14-0.16	7.4-7.8	4-16	Moderate	0.28	5	4L
Bearden	11-31	0.06-2.0	0.14-0.16	7.9-8.4	4-16	Moderate	0.32		
	31-60	0.2-0.6	0.11-0.13	7.9-8.4	4-16	Moderate	0.32		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
268, 271---------	0-7	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.28	5	6
Bottineau	7-25	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.28		
	25-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
314* 318*:									
Buse----------	0-7	0.2-0.6	0.17-0.22	6.6-8.4	<2	Low-------	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Barnes----------	0-6	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	6-18	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	18-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
389*:									
Cathay----------	0-9	0.6-2.0	0.20-0.23	6.1-7.8	<2	Low-------	0.32	3	5
	9-31	0.06-0.2	0.16-0.19	6.6-8.4	4-8	Moderate	0.32		
	31-60	0.2-2.0	0.17-0.19	7.4-9.0	4-8	Moderate	0.32		
Larson----------	0-12	0.6-2.0	0.16-0.24	6.1-7.3	<2	Moderate	0.32	3	5
	12-23	0.06-0.2	0.10-0.14	7.4-9.0	4-16	Moderate	0.32		
	23-60	0.2-2.0	0.12-0.16	7.9-9.0	2-8	Moderate	0.32		
392*:									
Cavour----------	0-7	0.6-2.0	0.18-0.22	6.1-7.8	<2	Moderate	0.37	3	6
	7-39	<0.06	0.10-0.16	6.6-9.0	4-16	High------	0.37		
	39-60	0.06-0.6	0.11-0.15	7.4-9.0	8-16	Moderate	0.37		
Cresbard--------	0-9	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low-------	0.32	3	6
	9-27	0.06-0.2	0.11-0.14	5.6-7.8	2-4	High------	0.32		
	27-44	0.06-0.2	0.11-0.15	6.1-8.4	2-4	High------	0.32		
	44-60	0.2-0.6	0.16-0.20	7.4-9.0	2-8	Moderate	0.32		
430*:									
Claire----------	0-4	6.0-20	0.06-0.10	6.1-7.3	<2	Low-------	0.15	5	1
	4-32	6.0-20	0.03-0.06	6.6-8.4	<2	Low-------	0.15		
	32-60	6.0-20	0.02-0.09	7.4-8.4	<2	Low-------	0.15		
Lohnes----------	0-14	6.0-20	0.08-0.10	6.6-7.8	<2	Low-------	0.15	5	2
	14-20	6.0-20	0.03-0.07	6.6-7.8	<2	Low-------	0.15		
	20-60	6.0-20	0.03-0.07	7.4-8.4	<2	Low-------	0.15		
450---------------	0-12	0.6-2.0	0.20-0.22	7.4-8.4	<2	Moderate	0.32	5	4L
Colvin	12-33	0.2-0.6	0.16-0.20	7.4-8.4	<2	Moderate	0.32		
	33-60	0.2-0.6	0.15-0.20	7.4-8.4	<2	Moderate	0.32		
451---------------	0-12	0.6-2.0	0.20-0.22	7.4-8.4	<2	Moderate	0.32	5	4L
Colvin	12-33	0.2-0.6	0.16-0.20	7.4-8.4	<2	Moderate	0.32		
	33-60	0.2-0.6	0.16-0.20	7.4-8.4	<2	Moderate	0.32		
452---------------	0-12	0.6-2.0	0.15-0.17	7.4-8.4	4-16	Moderate	0.32	5	4L
Colvin	12-60	0.2-0.6	0.11-0.15	7.4-8.4	4-16	Moderate	0.32		
453---------------	0-12	0.6-2.0	0.20-0.22	7.4-8.4	<2	Moderate	0.32	5	4L
Colvin	12-33	0.2-0.6	0.16-0.20	7.4-8.4	<2	Moderate	0.32		
	33-60	0.2-0.6	0.15-0.20	7.4-8.4	<2	Moderate	0.32		
470*:									
Cresbard--------	0-9	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low-------	0.32	3	6
	9-27	0.06-0.2	0.11-0.14	5.6-7.8	2-4	High------	0.32		
	27-44	0.06-0.2	0.11-0.15	6.1-8.4	2-4	High------	0.32		
	44-60	0.2-0.6	0.16-0.20	7.4-9.0	2-8	Moderate	0.32		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
470*:									
Barnes	0-6	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low	0.28	5	6
	6-18	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	18-42	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
	42-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
501*:									
Dickey	0-5	6.0-20	0.08-0.12	6.1-7.8	<2	Low	0.17	5	2
	5-32	6.0-20	0.06-0.12	6.1-7.8	<2	Low	0.17		
	32-60	0.6-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Esmond	0-7	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low	0.28	5	4L
	7-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Low	0.37		
502*:									
Dickey	0-5	6.0-20	0.08-0.12	6.1-7.8	<2	Low	0.17	5	2
	5-32	6.0-20	0.06-0.12	6.1-7.8	<2	Low	0.17		
	32-60	0.6-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Esmond	0-7	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low	0.28	5	4L
	7-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Low	0.37		
Maddock	0-6	6.0-20	0.08-0.12	6.6-7.8	<2	Low	0.17	5	2
	6-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low	0.17		
510	0-8	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low	0.28	4	4L
Divide	8-25	0.6-2.0	0.16-0.19	7.4-8.4	<2	Low	0.28		
	25-60	>20	0.03-0.07	7.4-8.4	<2	Low	0.10		
532	0-11	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low	0.28	5	5
Eckman	11-32	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low	0.43		
	32-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Low	0.43		
548	0-8	2.0-6.0	0.11-0.17	5.6-7.3	<2	Low	0.20	5	3
Egeland	8-15	2.0-6.0	0.09-0.15	6.1-7.8	<2	Low	0.20		
	15-60	2.0-6.0	0.08-0.10	6.6-8.4	<2	Low	0.20		
569	0-16	2.0-6.0	0.13-0.18	6.6-7.3	<2	Low	0.20	5	3
Embden	16-27	2.0-6.0	0.12-0.17	6.6-7.8	<2	Low	0.20		
	27-60	2.0-6.0	0.06-0.16	6.6-8.4	<2	Low	0.20		
601, 602	0-15	2.0-6.0	0.35-0.45	6.6-8.4	<2		0.10	5	8
Eramosh	15-60	0.6-2.0	0.16-0.22	7.4-8.4	<2	Moderate	0.43		
605*, 607*:									
Esmond	0-7	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low	0.28	5	4L
	7-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Low	0.37		
Heimdal	0-8	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low	0.28	5	5
	8-17	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low	0.28		
	17-60	0.6-2.0	0.11-0.21	7.9-8.4	<2	Low	0.37		
768	0-16	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low	0.28	5	5
Gardena	16-60	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low	0.43		
800	0-7	0.6-2.0	0.20-0.23	7.4-8.4	<4	Low	0.28	5	4L
Glyndon	7-29	0.6-2.0	0.17-0.20	7.9-8.4	<4	Low	0.28		
	29-60	0.6-2.0	0.15-0.22	7.4-8.4	<4	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	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
846*:									
Great Bend	0-8	0.6-2.0	0.19-0.22	6.1-7.8	<2	Moderate	0.32	5	6
	8-13	0.6-2.0	0.17-0.20	6.6-8.4	<2	Moderate	0.43		
	13-26	0.6-2.0	0.17-0.20	7.4-8.4	<2	Low	0.43		
	26-60	0.2-0.6	0.17-0.20	7.4-8.4	<4	Low	0.43		
Overly	0-14	0.2-0.6	0.22-0.24	6.6-7.8	<2	Moderate	0.32	5	6
	14-28	0.2-0.6	0.17-0.22	6.6-8.4	<2	Moderate	0.32		
	28-60	0.2-0.6	0.13-0.22	7.9-8.4	<2	Moderate	0.32		
863	0-7	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate	0.28	5	4L
Hamerly	7-29	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	29-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
864	0-7	0.6-2.0	0.12-0.15	7.4-8.4	4-16	Moderate	0.28	5	4L
Hamerly	7-29	0.6-2.0	0.10-0.13	7.4-8.4	4-16	Moderate	0.28		
	29-60	0.2-0.6	0.10-0.13	7.4-8.4	4-16	Moderate	0.37		
883*:									
Hamerly	0-7	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate	0.28	5	4L
	7-29	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	29-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Tonka	0-14	0.6-2.0	0.18-0.23	5.6-7.8	<2	Low	0.32	5	6
	14-34	0.06-0.2	0.14-0.19	5.6-7.8	<2	High	0.43		
	34-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	0.43		
Parnell	0-11	0.6-2.0	0.22-0.24	6.1-7.8	<2	Low	0.28	5	6
	11-37	0.06-0.2	0.13-0.19	6.1-7.8	<2	High	0.28		
	37-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High	0.28		
893	0-2	0.06-0.2	0.20-0.24	6.6-8.4	<2	Moderate	0.37	3	6
Harriet	2-24	<0.06	0.10-0.15	>7.3	4-16	High	0.37		
	24-60	0.06-0.2	0.10-0.15	>7.8	4-16	Moderate	0.37		
926	0-6	6.0-20	0.10-0.12	6.1-7.8	<2	Low	0.17	5	2
Hecla	6-26	6.0-20	0.10-0.12	6.1-7.8	<2	Low	0.17		
	26-60	6.0-20	0.06-0.10	6.1-8.4	<2	Low	0.17		
939*:									
Hecla	0-6	6.0-20	0.10-0.12	6.1-7.8	<2	Low	0.17	5	2
	6-26	6.0-20	0.10-0.12	6.1-7.8	<2	Low	0.17		
	26-60	6.0-20	0.06-0.10	6.1-8.4	<2	Low	0.17		
Hamar	0-12	6.0-20	0.10-0.12	6.1-7.8	<2	Low	0.17	5	2
	12-17	6.0-20	0.10-0.12	6.6-8.4	<2	Low	0.17		
	17-60	6.0-20	0.06-0.08	7.4-8.4	<2	Low	0.17		
987*:									
Heimdal	0-8	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low	0.28	5	5
	8-17	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low	0.28		
	17-60	0.6-2.0	0.11-0.21	7.9-8.4	<2	Low	0.37		
Emrick	0-7	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low	0.28	5	5
	7-33	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low	0.28		
	33-60	0.6-2.0	0.11-0.21	7.4-8.4	<2	Low	0.37		
992*:									
Heimdal	0-8	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low	0.28	5	5
	8-17	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low	0.28		
	17-60	0.6-2.0	0.11-0.21	7.9-8.4	<2	Low	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
992*:									
Emrick	0-7	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low	0.28	5	5
	7-33	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low	0.28		
	33-60	0.6-2.0	0.11-0.21	7.4-8.4	<2	Low	0.37		
Esmond	0-7	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low	0.28	5	4L
	7-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Low	0.37		
998*:									
Heimdal	0-8	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low	0.28	5	5
	8-17	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low	0.28		
	17-60	0.6-2.0	0.11-0.21	7.9-8.4	<2	Low	0.37		
Esmond	0-7	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low	0.28	5	4L
	7-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Low	0.37		
1013, 1014	0-4	0.6-2.0	0.20-0.22	5.6-7.3	<2	Low	0.28	5	6
Kelvin	4-23	0.2-0.6	0.14-0.19	4.5-7.8	<2	Moderate	0.37		
	23-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
1104*:									
Lanona	0-9	2.0-6.0	0.13-0.18	6.1-7.3	<2	Low	0.20	5	3
	9-29	2.0-6.0	0.12-0.17	6.6-7.8	<2	Low	0.24		
	29-60	0.2-0.6	0.16-0.20	7.4-8.4	<4	Moderate	0.32		
Swenoda	0-12	2.0-6.0	0.11-0.17	6.1-7.3	<2	Low	0.20	5	3
	12-28	2.0-6.0	0.11-0.17	6.6-7.8	<2	Low	0.20		
	28-60	0.2-0.6	0.17-0.20	7.4-8.4	<4	Moderate	0.37		
1140	0-8	0.6-2.0	0.11-0.17	5.1-7.8	<2	Low	0.20	3	3
Letcher	8-13	0.6-6.0	0.10-0.15	5.1-7.8	<2	Low	0.24		
	13-24	0.06-0.2	0.08-0.14	6.6-9.0	2-8	Low	0.24		
	24-60	0.6-2.0	0.11-0.18	7.4-9.0	2-8	Low	0.24		
1182	0-14	6.0-20	0.08-0.10	6.6-7.8	<2	Low	0.15	5	2
Lohnes	14-20	6.0-20	0.03-0.07	6.6-7.8	<2	Low	0.15		
	20-60	6.0-20	0.03-0.07	7.4-8.4	<2	Low	0.15		
1206	0-6	6.0-20	0.08-0.12	6.6-7.8	<2	Low	0.17	5	2
Maddock	6-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low	0.17		
1221*:									
Maddock	0-6	6.0-20	0.08-0.12	6.6-7.8	<2	Low	0.17	5	2
	6-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low	0.17		
Hecla	0-6	6.0-20	0.10-0.12	6.1-7.8	<2	Low	0.17	5	2
	6-26	6.0-20	0.10-0.12	6.1-7.8	<2	Low	0.17		
	26-60	6.0-20	0.06-0.10	6.1-8.4	<2	Low	0.17		
1269	0-18	0.6-2.0	0.17-0.22	7.9-8.4	<2	Moderate	0.28	4	4L
Marysland	18-32	0.6-2.0	0.15-0.19	7.9-8.4	<2	Moderate	0.28		
	32-60	6.0-20	0.02-0.07	7.9-8.4	<2	Low	0.15		
1291, 1292	0-5	2.0-6.0	0.10-0.15	5.6-7.3	<2	Low	0.20	3	3
Metigoshe	5-15	0.6-2.0	0.12-0.14	6.6-7.8	<2	Low	0.28		
	15-60	>20	0.02-0.05	6.6-8.4	<2	Low	0.10		
1300*:									
Miranda	0-2	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low	0.32	3	6
	2-8	<0.06	0.14-0.18	6.6-8.4	2-8	Moderate	0.32		
	8-60	<0.06	0.13-0.17	7.9-9.0	4-16	Moderate	0.32		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
1300*:									
Cavour	0-7	0.6-2.0	0.18-0.22	6.1-7.8	<2	Moderate	0.37	3	6
	7-39	<0.06	0.10-0.16	6.6-9.0	4-16	High	0.37		
	39-60	0.06-0.6	0.11-0.15	7.4-9.0	8-16	Moderate	0.37		
1426	0-11	0.6-2.0	0.22-0.24	6.1-7.8	<2	Low	0.28	5	6
Parnell	11-37	0.06-0.2	0.13-0.19	6.1-7.8	<2	High	0.28		
	37-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High	0.28		
1466. Pits, sand and gravel									
1523	0-6	0.6-2.0	0.18-0.20	6.1-7.8	<2	Low	0.28	3	5
Renshaw	6-16	0.6-6.0	0.11-0.18	6.6-8.4	<2	Low	0.28		
	16-60	>20	0.03-0.06	6.6-8.4	<2	Low	0.10		
1571, 1572	0-6	0.06-0.2	0.15-0.18	5.6-7.3	<2	High	0.32	5	4
Rolla	6-24	0.06-0.2	0.13-0.17	6.1-8.4	<2	High	0.32		
	24-60	0.06-0.2	0.13-0.17	7.4-8.4	<2	High	0.32		
1687, 1691	0-5	0.6-2.0	0.18-0.20	6.6-8.4	<2	Low	0.28	2	5
Sioux	5-9	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low	0.20		
	9-60	>20	0.03-0.06	7.4-8.4	<2	Low	0.10		
1709	0-6	0.2-0.6	0.22-0.24	6.6-8.4	2-8	Moderate	0.37	5	4L
Southam	6-26	0.06-0.2	0.14-0.20	6.6-8.4	2-8	High	0.28		
	26-60	0.06-0.6	0.13-0.17	7.4-9.0	2-8	High	0.28		
1727	0-7	2.0-6.0	0.10-0.13	7.4-8.4	2-8	Low	0.24	3	3
Stirum	7-16	0.2-0.6	0.12-0.18	>7.8	2-16	Low	0.32		
	16-60	2.0-6.0	0.06-0.18	>7.8	2-16	Low	0.17		
1780	0-12	2.0-6.0	0.11-0.17	6.1-7.3	<2	Low	0.20	5	3
Swenoda	12-28	2.0-6.0	0.11-0.17	6.6-7.8	<2	Low	0.20		
	28-60	0.2-0.6	0.17-0.20	7.4-8.4	<4	Moderate	0.37		
1843	0-10	6.0-20	0.08-0.12	6.6-7.8	<2	Low	0.17	5	2
Towner	10-31	6.0-20	0.06-0.13	6.6-7.8	<2	Low	0.17		
	31-60	0.2-0.6	0.14-0.22	7.4-8.4	<2	Moderate	0.37		
1859	0-8	2.0-6.0	0.13-0.18	7.4-8.4	<4	Low	0.17	5	3
Ulen	8-20	6.0-20	0.06-0.10	7.9-8.4	<4	Low	0.17		
	20-60	6.0-20	0.06-0.08	7.4-8.4	<4	Low	0.17		
1871	0-8	0.6-2.0	0.14-0.16	7.4-8.4	4-16	Low	0.28	5	4L
Vallers	8-30	0.2-0.6	0.10-0.13	7.4-8.4	4-16	Low	0.28		
	30-60	0.2-0.6	0.11-0.13	7.4-8.4	4-16	Low	0.28		
1978. Water									
2046	0-7	2.0-6.0	0.13-0.18	7.4-8.4	<2	Low	0.20	5	3
Wyndmere	7-29	2.0-6.0	0.12-0.17	7.4-8.4	<2	Low	0.20		
	29-60	2.0-6.0	0.06-0.16	7.4-8.4	<2	Low	0.20		
2059	0-24	2.0-6.0	0.12-0.20	6.6-8.4	<2	Low	0.20	4	3
Wyrene	24-60	6.0-20	0.02-0.07	7.4-8.4	<2	Low	0.15		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

("Flooding," "water table, and terms such as "frequent," "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			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
17*:										
Aberdeen	C	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Moderate.
Nahon	D	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Moderate.
64--Arveson	B/D	None	---	---	0-2.0	Apparent	Apr-Jul	High	High	Low.
66--Arveson	B/D	None	---	---	+1-1.0	Apparent	Jan-Dec	High	High	Low.
76--Arvilla	B	None	---	---	>6.0	---	---	Low	Moderate	Low.
118*, 120*:										
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Buse	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
135*:										
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Cresbard	C	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Moderate.
137*:										
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Hamerly	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	High	High	Low.
167--Bearden	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	High	High	Low.
169--Bearden	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	High	High	Moderate.
268, 271--Bottineau	B	None	---	---	>6.0	---	---	Moderate	High	Low.
314*, 318*:										
Buse	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
389*:										
Cathay	C	None	---	---	3.0-5.0	Apparent	Apr-Jun	Moderate	High	Moderate.
Larson	D	None	---	---	3.0-6.0	Apparent	Mar-Jun	Moderate	High	Moderate.
392*:										
Cavour	D	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Moderate.
Cresbard	C	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Moderate.
430*:										
Claire	A	None	---	---	>6.0	---	---	Low	Moderate	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
430*:										
Lohnes	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
450 Colvin	C/D	None	---	---	0-1.0	Apparent	Apr-Jul	High	High	Low.
451 Colvin	C/D	Frequent	Brief	Mar-Jul	0-1.0	Apparent	Apr-Jul	High	High	Low.
452 Colvin	C/D	None	---	---	0-2.0	Apparent	Apr-Jul	High	High	Moderate.
453 Colvin	C/D	None	---	---	+1-1.0	Apparent	Jan-Dec	High	High	Low.
470*:										
Cresbard	C	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Moderate.
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
501*:										
Dickey	B	None	---	---	>6.0	---	---	Low	High	Low.
Esmond	B	None	---	---	>6.0	---	---	Moderate	High	Low.
502*:										
Dickey	B	None	---	---	>6.0	---	---	Low	High	Low.
Esmond	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Maddock	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
510 Divide	B	None	---	---	2.5-5.0	Apparent	Apr-Jun	Moderate	High	Low.
532 Eckman	B	None	---	---	>6.0	---	---	High	Moderate	Low.
548 Egeland	B	None	---	---	>6.0	---	---	Low	Moderate	Low.
569 Embden	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Low.
601 Eramosh	D	None	---	---	+2-1.0	Apparent	Apr-Jul	High	High	Low.
602 Eramosh	D	None	---	---	+5-1.0	Apparent	Apr-Mar	High	High	Low.
605*, 607*:										
Esmond	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Heimdal	B	None	---	---	>6.0	---	---	Moderate	High	Low.
768 Gardena	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	High	Moderate	Low.
800 Glyndon	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	High	High	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
846*:										
Great Bend	B	None	---	---	>6.0	---	---	High	High	Moderate.
Overly	C	None	---	---	4.0-6.0	Apparent	Apr-Jun	High	High	Low.
863---------- Hamerly	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	High	High	Low.
864---------- Hamerly	C	None	---	---	2.0-4.0	Apparent	Sep-Jun	High	High	Moderate.
883*:										
Hamerly	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	High	High	Low.
Tonka	C/D	None	---	---	+.5-1.0	Apparent	Apr-Jun	High	High	Low.
Parnell	C/D	None	---	---	+2-2.0	Apparent	Jan-Dec	High	High	Low.
893---------- Harriet	D	Occasional	Long	Apr-Jun	0-1.0	Apparent	Sep-Jun	High	High	Moderate.
926---------- Hecla	A	None	---	---	3.0-6.0	Apparent	Apr-Oct	Moderate	Moderate	Low.
939*:										
Hecla	A	None	---	---	3.0-6.0	Apparent	Apr-Oct	Moderate	Moderate	Low.
Hamar	A/D	None	---	---	0-2.0	Apparent	Oct-Jun	Moderate	High	Low.
987*:										
Heimdal	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Emrick	B	None	---	---	>6.0	---	---	Moderate	High	Low.
992*:										
Heimdal	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Emrick	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Esmond	B	None	---	---	>6.0	---	---	Moderate	High	Low.
998*:										
Heimdal	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Esmond	B	None	---	---	>6.0	---	---	Moderate	High	Low.
1013, 1014-------- Kelvin	C	None	---	---	>6.0	---	---	Moderate	High	Low.
1104*:										
Lanona	B	None	---	---	>6.0	---	---	Moderate	High	Moderate.
Swenoda	B	None	---	---	2.5-4.0	Perched	Mar-Jun	Moderate	High	Moderate.
1140---------- Letcher	D	None	---	---	3.5-6.0	Perched	Nov-Jun	Moderate	High	Moderate.
1182---------- Lohnes	A	None	---	---	>6.0	---	---	Low	Moderate	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
1206--- Maddock	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
1221*:										
Maddock---	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
Hecla---	A	None	---	---	3.0-6.0	Apparent	Apr-Oct	Moderate	Moderate	Low.
1269--- Marysland	B/D	None	---	---	0-2.0	Apparent	Nov-Jul	High	High	Low.
1291, 1292--- Metigoshe	B	None	---	---	>6.0	---	---	Low	Moderate	Low.
1300*:										
Miranda---	D	None	---	---	2.0-4.0	Apparent	Apr-Jul	Moderate	High	Moderate.
Cavour---	D	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Moderate.
1426--- Parnell	C/D	None	---	---	+2-2.0	Apparent	Jan-Dec	High	High	Low.
1466. Pits, sand and gravel										
1523--- Renshaw	B	None	---	---	>6.0	---	---	Low	Moderate	Low.
1571, 1572--- Rolla	C	None	---	---	>6.0	---	---	Moderate	High	Low.
1687, 1691--- Sioux	A	None	---	---	>6.0	---	---	Low	Low	Low.
1709--- Southam	D	None	---	---	+5-1.0	Apparent	Jan-Dec	High	High	Low.
1727--- Stirum	B/D	None	---	---	1.0-3.0	Apparent	Apr-Jul	Moderate	High	Moderate.
1780--- Swenoda	B	None	---	---	2.5-4.0	Perched	Mar-Jun	Moderate	High	Moderate.
1843--- Towner	B	None	---	---	3.0-6.0	Perched	Apr-Jun	Moderate	High	Low.
1859--- Ulen	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	Moderate	Low	Low.
1871--- Vallers	C	None	---	---	0-1.0	Apparent	Apr-Jul	High	High	Moderate.
1978. Water										
2046--- Wyndmere	B	None	---	---	2.0-5.0	Apparent	Sep-Jun	High	High	Low.
2059--- Wyrene	B	None	---	---	3.0-5.0	Apparent	Mar-Jun	Moderate	High	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--ENGINEERING INDEX TEST DATA

(Dashes indicate that data were not available. All data supplied by the North Dakota State Highway Department, except for the Unified classification)

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution						Liquid limit	Plasticity index	Moisture density	
			Percentage passing sieve--					Percentage smaller than			Maximum dry density	Optimum moisture
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.005 mm				
									Pct		Lb/ft^3	Pct
Arveson loam (S87ND079-65)												
Bkg---- 19 to 23	A-2-4(0)	SC-SM	100	100	100	90	33	12	21	6	125	10
Cg----- 30 to 47	A-2-4(0)	SP-SM	100	100	100	87	11	6	---	0	123	11
Cresbard loam (S86ND079-47)												
Bt----- 19 to 27	A-7-6(12)	CL	99	97	97	88	67	35	41	21	114	14
Bk----- 27 to 44	A-7-6(16)	CL	100	98	97	89	69	39	46	26	113	14
Eckman silt loam (S87ND079-68)												
Bk----- 15 to 32	A-4(7)	ML	100	100	100	100	94	23	32	7	109	15
C------ 48 to 60	A-4(0)	ML	100	100	100	100	88	8	0	0	114	14
Heimdal loam (S86ND079-48)												
Bw----- 8 to 15	A-6(5)	CL	98	97	97	89	59	22	31	13	121	11
Bk----- 20 to 35	A-4(5)	CL	100	99	98	88	71	22	25	10	127	9
Letcher fine sandy loam (S88ND079-49)												
Bt----- 10 to 17	A-2-6(0)	SC	100	100	100	96	35	18	28	11	125	10
Bk----- 22 to 32	A-4(0)	SC	100	100	100	97	38	27	23	9	123	12
Wyndmere fine sandy loam (S89ND079-143)												
Bk----- 10 to 18	A-4(1)	SC	100	100	100	86	43	23	26	9	120	12
C1----- 29 to 50	A-2-4(0)	SM	100	100	100	98	34	11	---	0	122	12
Wyrene sandy loam (S88ND079-72)												
Bk----- 15 to 24	A-2-4(0)	SC	94	88	80	64	28	11	23	8	128	10
C------ 24 to 44	A-1-6(0)	SP-SM	87	77	65	33	6	1	---	0	125	10

TABLE 18.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Aberdeen	Fine, montmorillonitic Glossic Udic Natriborolls
Arveson	Coarse-loamy, frigid Typic Calciaquolls
Arvilla	Sandy, mixed Udic Haploborolls
Barnes	Fine-loamy, mixed Udic Haploborolls
Bearden	Fine-silty, frigid Aeric Calciaquolls
Bottineau	Fine-loamy, mixed Udic Argiborolls
Buse	Fine-loamy, mixed Udorthentic Haploborolls
Cathay	Fine-loamy, mixed Glossic Udic Natriborolls
Cavour	Fine, montmorillonitic Udic Natriborolls
Claire	Mixed, frigid Typic Udipsamments
Colvin	Fine-silty, frigid Typic Calciaquolls
Cresbard	Fine, montmorillonitic Glossic Udic Natriborolls
Dickey	Sandy over loamy, mixed Udorthentic Haploborolls
Divide	Fine-loamy over sandy or sandy-skeletal, frigid Aeric Calciaquolls
Eckman	Coarse-silty, mixed Udic Haploborolls
Egeland	Coarse-loamy, mixed Udic Haploborolls
Embden	Coarse-loamy, mixed Pachic Udic Haploborolls
Emrick	Coarse-loamy, mixed Pachic Udic Haploborolls
Eramosh	Fine-silty, mixed (calcareous), frigid Histic Haplaquolls
Esmond	Coarse-loamy, mixed Udorthentic Haploborolls
Gardena	Coarse-silty, mixed Pachic Udic Haploborolls
Glyndon	Coarse-silty, frigid Aeric Calciaquolls
Great Bend	Fine-silty, mixed Udic Haploborolls
Hamar	Sandy, mixed, frigid Typic Haplaquolls
Hamerly	Fine-loamy, frigid Aeric Calciaquolls
Harriet	Fine, montmorillonitic, frigid Typic Natraquolls
Hecla	Sandy, mixed Aquic Haploborolls
Heimdal	Coarse-loamy, mixed Udic Haploborolls
Kelvin	Fine, montmorillonitic Typic Eutroboralfs
Lanona	Coarse-loamy, mixed Udic Haploborolls
Larson	Fine-loamy, mixed Udic Natriborolls
Letcher	Coarse-loamy, mixed Udic Natriborolls
Lohnes	Sandy, mixed Udorthentic Haploborolls
Maddock	Sandy, mixed Udorthentic Haploborolls
Marysland	Fine-loamy over sandy or sandy-skeletal, frigid Typic Calciaquolls
Metigoshe	Coarse-loamy, mixed Boralfic Udic Argiborolls
Miranda	Fine-loamy, mixed Leptic Natriborolls
Nahon	Fine, montmorillonitic Udic Natriborolls
Overly	Fine-silty, mixed Pachic Udic Haploborolls
Parnell	Fine, montmorillonitic, frigid Typic Argiaquolls
Renshaw	Fine-loamy over sandy or sandy-skeletal, mixed Udic Haploborolls
Rolla	Very fine, montmorillonitic Typic Eutroboralfs
Sioux	Sandy-skeletal, mixed Udorthentic Haploborolls
Southam	Fine, montmorillonitic (calcareous), frigid Cumulic Haplaquolls
Stirum	Coarse-loamy, mixed, frigid Typic Natraquolls
Swenoda	Coarse-loamy, mixed Pachic Udic Haploborolls
Tonka	Fine, montmorillonitic, frigid Argiaquic Argialbolls
Towner	Sandy over loamy, mixed Udorthentic Haploborolls
Ulen	Sandy, frigid Aeric Calciaquolls
Vallers	Fine-loamy, frigid Typic Calciaquolls
Wyndmere	Coarse-loamy, frigid Aeric Calciaquolls
Wyrene	Sandy, frigid Aeric Calciaquolls

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