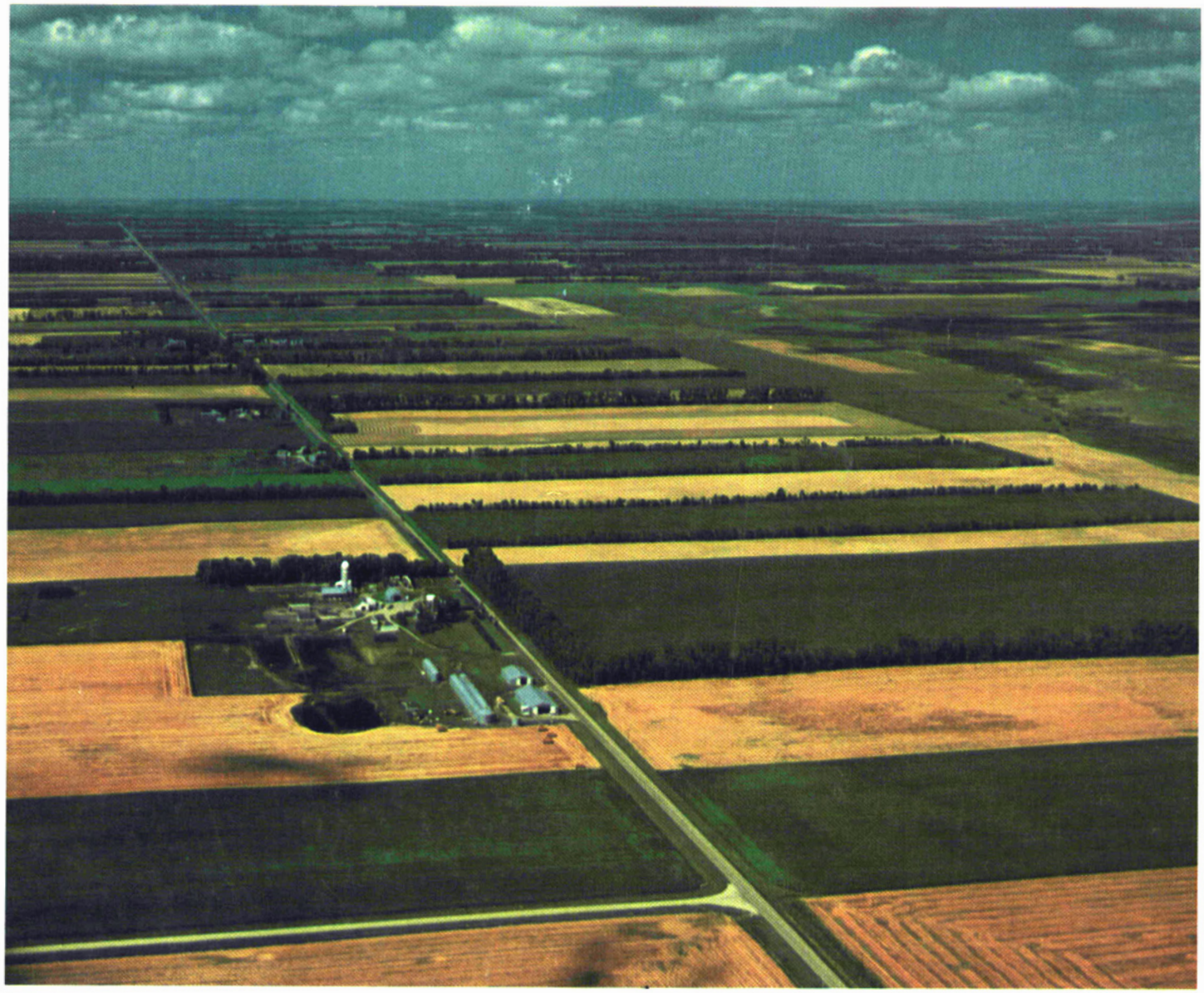
United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with the
South Dakota Agricultural
Experiment Station

Soil Survey of Brown County, South Dakota



How To Use This Soil Survey

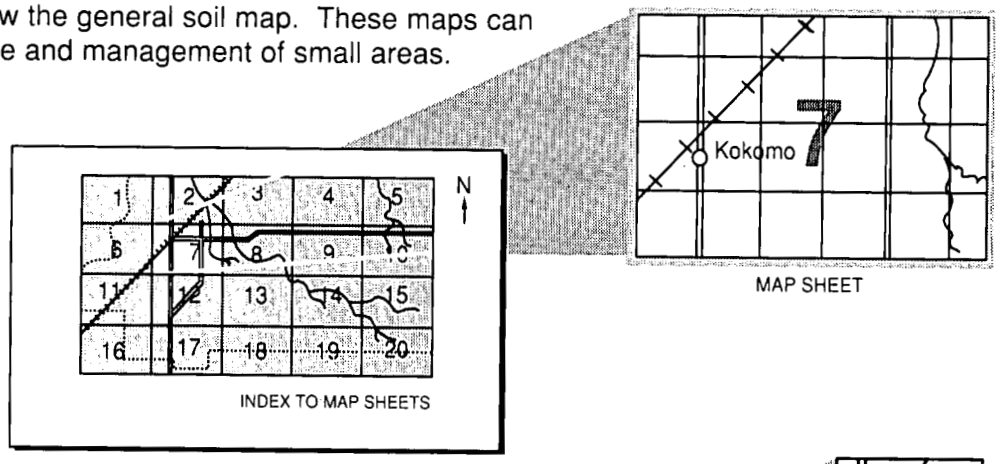
General Soil Map

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.

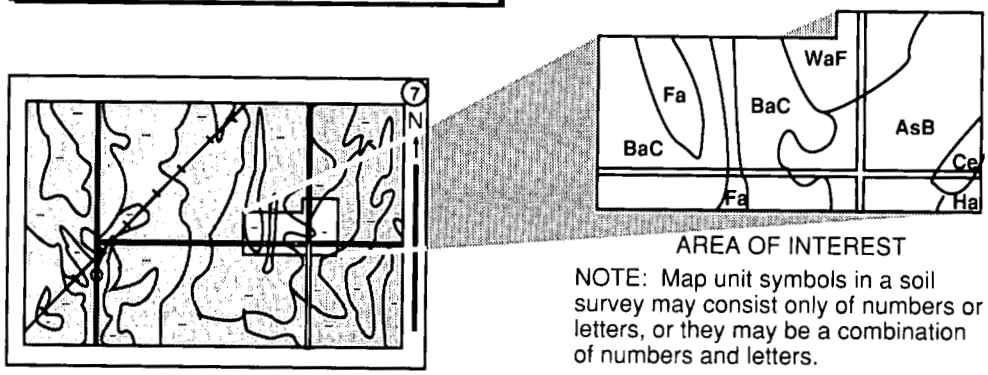
To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

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.



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.

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.

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 Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1986. Soil names and descriptions were approved in 1987. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1987. This survey was made cooperatively by the Soil Conservation Service and the South Dakota Agricultural Experiment Station. It is part of the technical assistance furnished to the Brown County Conservation District. Some financial assistance was furnished by the South Dakota Department of Revenue and the Brown County Board of Commissioners.

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.

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

Cover: Field windbreaks and stripcropping in an area of Eckman and Gardena soils.

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Foreword

This soil survey contains information that can be used in land-planning programs in Brown 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 over bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

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

Ronald E. Hendricks

Ronald E. Hendricks
State Conservationist
Soil Conservation Service

Soil Survey of
Brown County, South Dakota

By Loren D. Schultz, Soil Conservation Service

Fieldwork by Loren D. Schultz, Robert R. Blank, James A. Clausen, Steven K. Fischer, Roland K. Krauss, and Thomas J. Martin, Soil Conservation Service

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

BROWN COUNTY is in the north-central part of South Dakota (fig. 1). It has a total area of 1,683 square miles, or 1,107,891 acres. Of this total, about 13,951 acres is water.

In 1980, the county had a population of 36,962. The population of Aberdeen, the county seat, was 25,851; that of Frederick, in the northwestern part of the county, was 307; that of Groton, in the southeastern part, was 1,230; and that of Hecla, in the northeastern part, was 435. Other towns in the county are Barnard, Bath, Columbia, Claremont, Ferney, Houghton, Mansfield, Stratford, Verdon, Warner, and Westport.

About 67 percent of the acreage in the county is cropland, 22 percent is rangeland, and 5 percent is tame pasture and hay. The rest is used as wildlife habitat or for urban development or consists of small areas of water. Spring wheat, corn, barley, alfalfa, sunflowers, soybeans, and oats are the major crops. Winter wheat, corn for silage, flax, sorghum, and rye also are important. Growing cash crops and hay, raising beef cattle, and dairying are the main farm enterprises.

This soil survey updates the survey of Brown County published in 1925 *(13)*. It provides additional information and larger maps, which show the soils in greater detail.

General Nature of the County

This section gives general information concerning the county. It describes climate; physiography, relief, and drainage; settlement; farming; and natural resources.

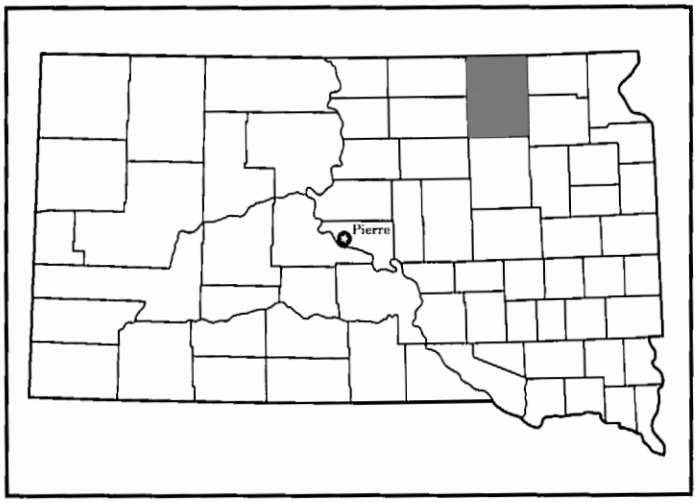

Figure 1.—Location of Brown County in South Dakota.

Climate

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

Table 1 gives data on temperature and precipitation for the survey area as recorded at Aberdeen, South Dakota, in the period 1951 to 1981. 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 13 degrees F and the average daily minimum temperature is 3 degrees. The lowest temperature on record, which occurred at Aberdeen on December 31, 1967, is -39 degrees. In summer, the average temperature is 70 degrees and the average daily maximum temperature is 83 degrees. The highest recorded temperature, which occurred at Aberdeen on August 13, 1965, is 112 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, about 13 inches, or about 75 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 11 inches. The heaviest 1-day rainfall during the period of record was 3.83 inches on June 23, 1978. Thunderstorms occur on about 36 days each year. Hail during these summer storms occurs in small scattered areas.

The average seasonal snowfall is about 35 inches. The greatest snow depth at any one time during the period of record was 25 inches. On the average, 46 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. Several times each winter, storms with snow and high winds bring blizzard conditions to the area.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 55 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 13 miles per hour, in spring.

Physiography, Relief, and Drainage

Brown County is in the James River Lowland physiographic division *(4)*. The major landforms are a lake plain, glacial uplands, and alluvial flood plains.

The eastern two-thirds of the county is a nearly flat plain that is between 1,290 and 1,310 feet above sea level. The plain is the former bed of an extensive but shallow and short-lived glacial lake known as Lake Dakota. This lake was about 90 miles long and 27 miles wide. It extended from southern Spink County to about 15 miles north of the North Dakota-South Dakota state line. The lake plain does not have a well developed natural drainage system.

The glacial uplands lie west of the lake plain and in the southeast corner of the county. They consist of deposits of glacial till that form smoothly rolling hills. The relief is dominantly undulating to hilly. The uplands range in elevation from 1,310 feet on the east side to 1,525 feet in the northwestern part of the county. They are characterized by many potholes or closed basins and have a poorly defined drainage pattern.

Flood plains are along the major streams, including the James, Elm, and Maple Rivers and Mud and Moccasin Creeks. The James River flood plain is 15 to 20 feet below the level of the Lake Dakota plain and ranges from ¼ to ¾ mile in width. The valleys of the Elm and Maple Rivers are much wider than the present flow and erosive power of these streams because they were formed by great streams of glacial meltwater, which cut wide valleys and deep channels. Today only minor streams occupy these large valleys.

The James River and its tributaries form the natural drainage network of Brown County. The James River flows southward at a low gradient across the county. From the North Dakota state line to Columbia, the river flows near the west side of the Lake Dakota plain. South of Columbia, its course is in the center of the plain. The low-water channel is 20 to 30 feet wide and has abrupt banks 5 to 10 feet high.

The principal tributaries of the James River are the Elm River and Moccasin Creek, both of which join the James River from the west. The Elm River enters the county near the northwest corner and flows to the southeast. The head of Moccasin Creek is near the Elm River. During periods of flooding, water from the Elm River flows into Moccasin Creek.

Mud Creek drains the southeastern part of Brown County and joins the James River from the east in Spink County.

Settlement

By 1822, a trading post had been established in what is now Brown County. In 1838, John C. Fremont explored the area along the James River *(8)*. No attempt was made to settle the area until 1877, when two covered wagons arrived. In 1879, the town of Columbia was established at the point where the Elm River merges with the James River. At that time, the James River was navigable and a steamboat connected Columbia with points in North Dakota.

Columbia was selected as the county seat in 1880 in

a highly disputed election. Attempts to divide the county were made in 1883 and 1885. Both ended in failure, but Aberdeen legislators managed to win approval from the Territorial Legislature for a special election to determine the county seat. In this election, which was held in 1887, Aberdeen was selected as the new county seat. In 1889, the Territorial Supreme Court upheld Columbia's claim that federal laws banning special legislation in the territories had been violated and the county seat was returned to Columbia. A year later, South Dakota was admitted to the Union as a state. Its new constitution provided for an election to determine the county seat in cases where it had not already been determined by a majority vote. The population of Aberdeen had grown rapidly during the 1880's because the main line of the Milwaukee Railroad had been built through the town. Thus Aberdeen, having considerably more votes, easily won the 1890 election and became Brown County's final county seat.

In 1890, Brown County had a population of 16,855. During the next 10 years, the population dropped slightly to 15,286. By 1930, the total population had risen to 31,458. After a slight decline in 1940, it reached a high of 36,962 in 1980.

Railroads have played an important role in the settlement of Brown County. In addition to the boost in Aberdeen's population as a result of the Milwaukee main line, many small villages sprang up along the main line and along branch lines leading to the city. Among these are Huffton, James, Nahon, Ordway, Plana, Putney, Randolph, Richmond, Rudolph, and Winship. Today Brown County is served by two major railroads. The main highways are U.S. Highways 12 and 281 and South Dakota Highways 10 and 37. Most rural areas are served by all-weather roads, which carry traffic to centers of trade. Aberdeen also has airline service.

Farming

Farming is the principal enterprise in Brown County. The first settlers grew mostly wheat, but the sandy soils in the northern part of the county later proved to be very good for the production of corn. After many years of intensive farming, the hazard of erosion began to increase. As the years passed, wind erosion became more severe. During the 1930's, the soil drifted badly, covering fences and forming hummocks and sand dunes in the fields. Operators could do nothing to control the extensive wind erosion.

In 1937, the South Dakota Soil Conservation District Law was passed. This law provided for the organization of Soil Conservation Districts. Local farmers formed the Brown-Marshall Conservation District later that year *(7)*. Conservation practices were established to maintain productivity or return the land to a productive state. Foremost among these practices was the shelterbelt program. Other practices established were crop residue management, stripcropping, level terraces, crop rotation, farmstead plantings, dune stabilization, pasture planting, proper grazing, and stock water ponds. The original district included the northern half of Brown County and parts of adjoining Marshall County. Today the Brown-Marshall District consists of the northern half of Brown County.

Although erosion was not so severe on the more silty and clayey soils in the southern half of the county as it was in the northern part, the South Brown Conservation District was formed in 1949. Many of the same conservation practices were established in this district.

In 1987, there were 1,183 farms in Brown County. The average farm size was 830 acres. The trend is toward fewer and larger farms. About 72 percent of the county is used as cropland and tame pasture.

In 1988, about 250,000 acres was used for wheat and 105,500 acres was used for corn, of which 23,400 acres was harvested for silage. About 66,500 acres was used for barley; 35,700 acres for soybeans; 25,000 acres for oats; 24,500 acres for sunflowers; 6,500 acres for rye; and 4,300 acres for flax. The rest was harvested for grain.

Natural Resources

Soil is the most important natural resource in Brown County. It provides a growing medium for crops and for the grass grazed by livestock. Other natural resources are ground water, wildlife, and sand and gravel.

The principal source of water for domestic use and for livestock is deep wells. Shallow wells also provide a source of water. Water quantity generally is greater in deep wells, but the quality is poor because of a high content of soluble salts. Dugouts in areas of Fossum, Heil, Nishon, Parnell, and Tonka soils provide additional water for livestock and wildlife. Elm, Mud, Pigors, Richmond, Sand, and Willow Lakes provide opportunities for fishing, boating, and waterfowl hunting. The area in and around Sand Lake National Wildlife Refuge is especially popular for waterfowl hunting. The drainageways flow intermittently and provide water only during periods of snowmelt and high rainfall. In some areas shallow ground water of good quality is available in sufficient volume for irrigation.

Sand and gravel are deposited in scattered areas throughout the western third of the county *(5)*. Most of the deposits contain materials with a wide range in grain size and in content of silt and clay.

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 state 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 several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including

areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

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

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.

The eighteen associations on the general soil map in this soil survey have been grouped for broad interpretive purposes. The associations and the groups are described on the pages that follow. The names of the associations do not coincide exactly with those on the general soil maps in the published surveys of Edmunds, Marshall, and McPherson Counties, South Dakota, and La Moure County, North Dakota, which are adjacent to this county. Differences are the result of variations in the design and composition of map units or changes and refinements in series concepts.

Soil Descriptions

Level to Rolling, Sandy and Loamy Soils on Glacial Lake Plains

These soils formed mainly in glaciolacustrine deposits. They are dominantly level to gently sloping but are rolling in areas where the wind has shifted sandy material into dunelike relief. These soils make up about 11 percent of the county. About 70 percent of the acreage is used as cropland. Wheat, corn, oats, barley, rye, and alfalfa are the main crops. Most of the level, sandy and loamy soils are used for crops. The excessively drained soils and the very poorly drained soils support grasses and are used mainly for grazing or hay.

1. Serden-Hamar-Venlo Association

Excessively drained, somewhat poorly drained, and very poorly drained, level to rolling, sandy soils on glacial lake plains

This association is on glacial lake plains characterized by sand dunes, ridges, knolls, and flats interspersed with swells and swales. Slopes are short and well rounded. The drainage pattern is poorly defined.

This association makes up about 0.5 percent of the county. It is about 45 percent Serden soils, 20 percent Hamar soils, 15 percent Venlo soils, and 20 percent minor soils (fig. 2).

The excessively drained Serden soils are on shoulder slopes and back slopes. Slopes range from 0 to 15 percent. Typically, the surface layer is dark gray loamy fine sand. The next layer is dark grayish brown fine sand. The underlying material is grayish brown fine sand.

The somewhat poorly drained Hamar soils are on the lower foot slopes and toe slopes. Slopes range from 0 to 3 percent. Typically, the surface layer is dark gray loamy fine sand. The underlying material is grayish brown fine sand.

The very poorly drained Venlo soils are in basins. Slopes are less than 1 percent. Typically, the surface layer is very dark gray loamy fine sand. The underlying material is light olive gray, light gray, and gray fine sand.

Minor in this association are Arveson, Fossum, Hecla, Maddock, and Ulen soils. Arveson, Fossum, and Ulen soils have free carbonates at the surface. Arveson and Fossum soils are in basins. Ulen soils are on toe slopes between and around the basins. The moderately well drained Hecla soils are on foot slopes above the Hamar soils. The well drained Maddock soils are on the lower back slopes below the Serden soils and above the Hamar soils.

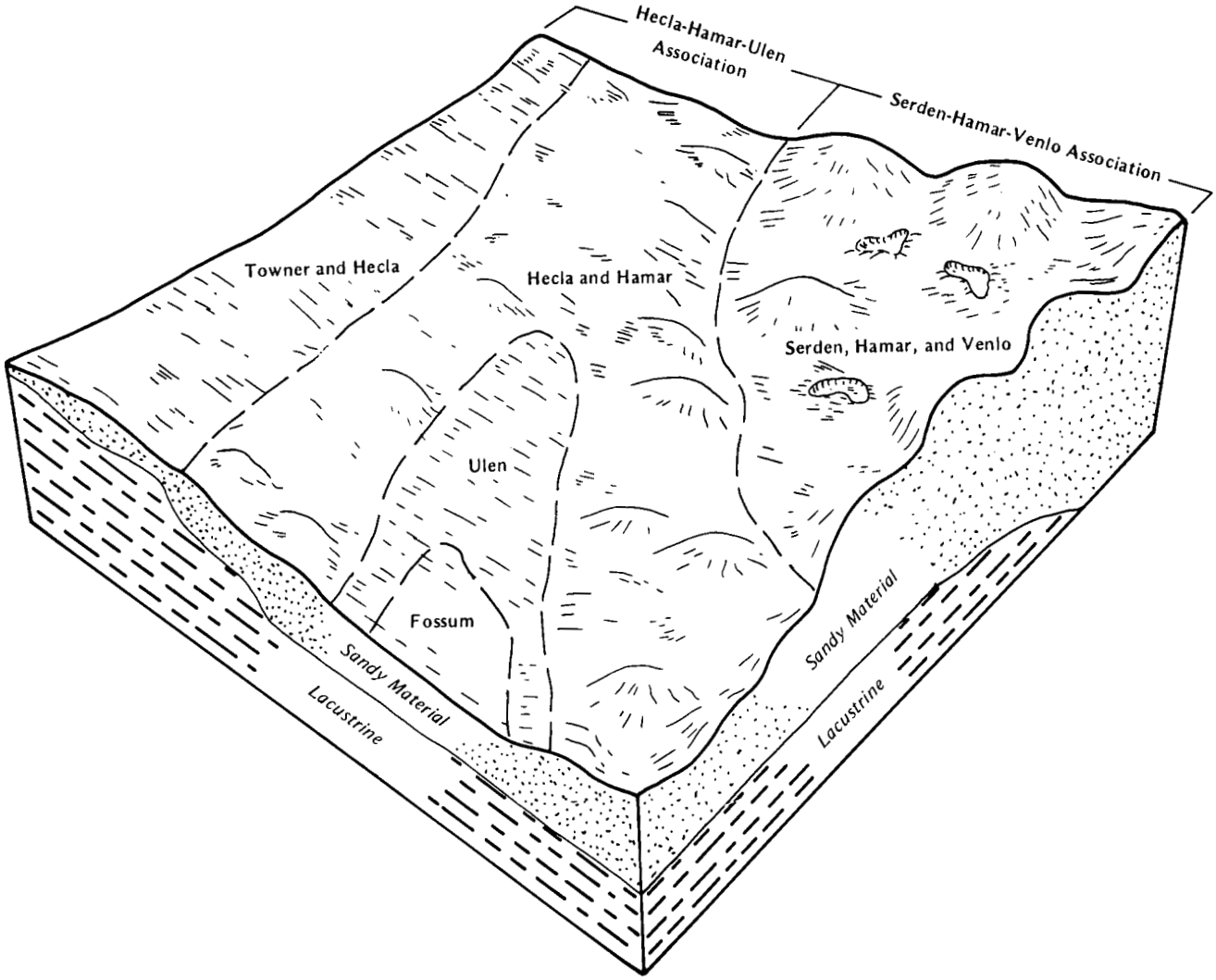

Figure 2.—Typical pattern of soils and parent material in the Serden-Hamar-Venlo and Hecla-Hamar-Ulen associations.

About 95 percent of this association is range. Controlling wind erosion and conserving moisture are the main management concerns.

This association is unsuited to cultivated crops, tame pasture and hay, and openland wildlife habitat because of the susceptibility to wind erosion, a low available water capacity, and the dunelike relief caused by past erosion. Wetness also is a limitation in the Hamar and Venlo soils. The association is suited to range and to rangeland wildlife habitat, but vegetation is sparse on the Serden soils and wetness in the Hamar and Venlo soils is a limitation. The Venlo soils are suited to wetland wildlife habitat.

The Serden soils are suited to building site development, but the sides of shallow excavations can cave in unless they are shored. The Hamar and Venlo soils are unsuited to building site development because of the wetness. This association is unsuited to septic tank absorption fields because of a poor filtering capacity in the Serden soils and the wetness in the Hamar and Venlo soils.

2. Hecla-Hamar-Ulen Association

Moderately well drained and somewhat poorly drained, nearly level to undulating, sandy and loamy soils on glacial lake plains

This association is in areas on glacial lake plains where flats are marked by many very gentle and gentle undulations interrupted by swell and swale topography.

A few areas are hummocky. Slopes are short and well rounded. The drainage pattern is poorly defined.

This association makes up about 7 percent of the county. It is about 35 percent Hecla soils, 20 percent Hamar soils, 15 percent Ulen soils, and 30 percent minor soils (fig. 2).

The moderately well drained Hecla soils are on foot slopes. Slopes range from 0 to 6 percent. Typically, the surface layer is dark gray loamy fine sand. The next layer is dark gray fine sand. The underlying material is grayish brown fine sand and very dark gray fine sandy loam.

The somewhat poorly drained Hamar soils are on the upper toe slopes. Slopes range from 0 to 3 percent. Typically, the surface layer is dark gray loamy fine sand. The underlying material is grayish brown fine sand.

The moderately well drained and somewhat poorly drained Ulen soils are on the lower toe slopes between and around the edges of basins. Slopes range from 0 to 3 percent. Typically, the surface layer is dark gray, calcareous fine sandy loam. The subsoil is gray, calcareous fine sandy loam and light gray, calcareous loamy fine sand. The underlying material is light gray, calcareous loamy fine sand and fine sand.

Minor in this association are Arveson, Embden, Fossum, Maddock, Stirum, Swenoda, and Towner soils. The poorly drained and very poorly drained Arveson and Fossum soils are in basins. Embden soils contain more clay and less sand than the major soils. They are in positions on the landscape similar to those of the Hecla soils. The well drained Maddock soils are in the higher positions on the landscape. Stirum soils have a sodium-affected subsoil and are slightly lower on the landscape than the Hamar soils. Swenoda and Towner soils have silt within a depth of 40 inches. They are slightly higher on the landscape than the Hecla soils.

About 55 percent of this association is cropland. Corn, wheat, oats, barley, and alfalfa are the main crops. Controlling wind erosion and conserving moisture are the main management concerns.

This association is suited to cultivated crops, tame pasture and hay, range, and openland and rangeland wildlife habitat. Wind erosion is a hazard on the Hecla and Ulen soils, and wetness is a limitation in the Hamar soils. The Hecla soils are suited to building site development, but the high water table is a limitation. The Hamar and Ulen soils are generally unsuited to building site development because of the wetness. This association is generally unsuited to septic tank absorption fields because of the wetness.

3. Wyndmere-Stirum Association

Somewhat poorly drained, level to gently undulating, loamy soils and poorly drained, level to gently undulating, sodium-affected, loamy soils; on glacial lake plains

This association is on glacial lake plains along Crow Creek. The landscape is characterized by toe slopes interrupted by many microlows. The drainage pattern is poorly defined.

This association makes up about 0.5 percent of the county. It is about 40 percent Wyndmere soils, 25 percent Stirum soils, and 35 percent minor soils.

The somewhat poorly drained Wyndmere soils are on the upper toe slopes. Slopes are less than 3 percent. Typically, the surface layer is dark gray, calcareous fine sandy loam. The subsoil is gray and light gray, calcareous fine sandy loam. The underlying material is light brownish gray and light yellowish brown, calcareous loamy very fine sand.

The poorly drained Stirum soils are on the lower toe slopes and in microlows. Slopes range from 0 to 3 percent. Typically, the surface layer is very dark gray, calcareous fine sandy loam. The subsoil is dark gray, light brownish gray, and light gray, calcareous loam. The underlying material is light gray, calcareous loamy very fine sand and loamy fine sand.

Minor in this association are Bearden, Colvin, Stirum Variant, Swenoda, Turton, Turton Variant, and Ulen soils. The somewhat poorly drained Bearden soils and the poorly drained and very poorly drained Colvin soils are in positions on the landscape similar to those of the Wyndmere soils. They contain more silt than the major soils. Stirum Variant, Turton, and Turton Variant soils have a sodium-affected subsoil. The poorly drained Stirum Variant and somewhat poorly drained Turton Variant soils are in microlows. The moderately well drained and somewhat poorly drained Turton soils are in positions on the landscape similar to those of the Wyndmere soils. The moderately well drained Swenoda soils are in the slightly higher positions on the landscape. The moderately well drained and somewhat poorly drained Ulen soils are in positions on the landscape similar to those of the Wyndmere soils. They contain more sand than the Wyndmere soils.

About 60 percent of this association is range. Some areas are used as cropland. Wheat, barley, oats, rye, and alfalfa are the main crops. Controlling wind erosion and improving fertility in areas of both soils and improving tilth in the Stirum soils are the main management concerns.

This association is suited to range, cultivated crops, tame pasture and hay, and openland and rangeland

wildlife habitat. Wetness in both soils and the sodium-affected subsoil in the Stirum soils are limitations. The association is generally unsuited to building site development and septic tank absorption fields because of the wetness.

4. Swenoda-Embden-Turton Association

Well drained and moderately well drained, level to gently sloping, loamy soils and moderately well drained and somewhat poorly drained, level and nearly level, sodium-affected, loamy soils; on glacial lake plains

This association is on glacial lake plains characterized by flats and rises. Smooth slopes and gentle undulations are interrupted by many microlows.

This association makes up about 3 percent of the county. It is about 35 percent Swenoda soils, 25 percent Embden soils, 20 percent Turton soils, and 20 percent minor soils.

The moderately well drained Swenoda soils are on the upper foot slopes. Slopes range from 0 to 6 percent. Typically, the surface layer is dark gray fine sandy loam. The subsoil is dark grayish brown, grayish brown, and white fine sandy loam. It is calcareous in the lower part. The underlying material is light gray and pale yellow, calcareous silt loam.

The well drained and moderately well drained Embden soils are on the lower foot slopes. Slopes range from 0 to 6 percent. Typically, the surface layer is dark gray fine sandy loam. The subsoil is grayish brown and light gray fine sandy loam. It is calcareous in the lower part. The underlying material is light gray, calcareous very fine sandy loam.

The moderately well drained and somewhat poorly drained Turton soils are on toe slopes. Slopes are 0 to 2 percent. Typically, the surface layer is dark gray loam. The subsurface layer is light brownish gray very fine sandy loam. The subsoil is grayish brown and light brownish gray loam. In the lower part it is calcareous and has nests of salt. The underlying material is light gray, calcareous very fine sandy loam.

Minor in this association are Camtown, Egeland, Tiffany, Tiffany Variant, Turton Variant, and Wyndmere soils. The moderately well drained Camtown soils are on the lower foot slopes. They have a sodium-affected subsoil that does not have columnar structure. Egeland soils are dark to a depth of less than 16 inches. They are on the upper back slopes. The somewhat poorly drained and poorly drained Tiffany and Tiffany Variant soils are in basins. Turton Variant soils have salts within a depth of 16 inches. They are in positions on the landscape similar to those of the Turton soils. Wyndmere soils have free carbonates at the surface. They are on the lower toe slopes.

About 85 percent of this association is cropland. Corn, wheat, oats, barley, and alfalfa are the main crops. Measures that control erosion and conserve moisture in the Swenoda and Embden soils and increase the rate of water intake in the Turton soils are the main management needs.

This association is suited to cultivated crops, tame pasture and hay, range, and openland and rangeland wildlife habitat. Wind erosion is a hazard on the Swenoda and Embden soils, and the sodium-affected subsoil in the Turton soils is a limitation.

This association is suited to building site development, but wetness is a limitation in all three soils and a moderate shrink-swell potential is a limitation in the Swenoda and Turton soils. The association is suited to septic tank absorption fields, but wetness is a limitation in all three soils and restricted permeability is a limitation in the Swenoda and Turton soils.

Level to Moderately Sloping, Loamy and Silty Soils on Glacial Lake Plains

These soils formed in glaciolacustrine deposits. They are dominantly level to moderately sloping but are strongly sloping along some drainageways. They make up about 26 percent of the county. About 90 percent of the acreage is cropland. Wheat, corn, sunflowers, oats, barley, soybeans, and alfalfa are the main crops.

5. Eckman-Gardena Association

Well drained and moderately well drained, nearly level to moderately sloping, loamy soils on glacial lake plains

This association is on lake plains characterized by long, smooth slopes. Flats and slight rises are interrupted by a few drainage channels.

This association makes up about 4 percent of the county. It is about 45 percent Eckman soils, 25 percent Gardena soils, and 30 percent minor soils.

The well drained Eckman soils are on back slopes. Slopes range from 0 to 9 percent. Typically, the surface layer is dark grayish brown very fine sandy loam. The subsoil is grayish brown and light brownish gray very fine sandy loam and silt loam. It is calcareous in the lower part. The underlying material is light gray, calcareous very fine sandy loam.

The well drained and moderately well drained Gardena soils are on foot slopes. Slopes range from 0 to 6 percent. Typically, the surface layer is dark gray very fine sandy loam. The subsoil is grayish brown and light gray, friable silt loam. It is calcareous in the lower part. The underlying material is light gray, calcareous silt loam.

Minor in this association are Beotia, Borup,

Camtown, Egeland, Embden, Glyndon, Great Bend, Turton, Turton Variant, and Zell soils. Beotia, Egeland, Embden, and Great Bend soils are in positions on the landscape similar to those of the major soils. Beotia and Great Bend soils contain more clay and less sand than the major soils, and Egeland and Embden soils contain more sand and less silt. The poorly drained Borup soils and the moderately well drained and somewhat poorly drained Glyndon soils are on toe slopes. They have free carbonates at the surface. Camtown, Turton, and Turton Variant soils have a sodium-affected subsoil. Camtown and Turton soils are on back slopes, and Turton Variant soils are on toe slopes. Zell soils are on shoulder slopes. They have free carbonates at the surface.

About 90 percent of this association is cropland. Corn, wheat, oats, soybeans, and alfalfa are the main crops. Measures that control erosion and conserve moisture are the main management needs.

This association is suited to cultivated crops, tame pasture and hay, range, and openland and rangeland wildlife habitat. It is suited to building site development and septic tank absorption fields, but wetness is a limitation in the Gardena soils.

6. Beotia-Bearden Association

Well drained and somewhat poorly drained, level to gently sloping, silty soils on glacial lake plains

This association is on glacial lake plains. Slopes generally are level to gently sloping. The drainage pattern is poorly defined.

This association makes up about 1 percent of the county. It is about 45 percent Beotia soils, 25 percent Bearden soils, and 30 percent minor soils.

The well drained Beotia soils are on foot slopes. Slopes range from 0 to 6 percent. Typically, the surface layer is dark gray silt loam. The subsoil is grayish brown silty clay loam and silt loam in the upper part and pale yellow, calcareous silt loam in the lower part. The underlying material is pale yellow, varved, calcareous silt loam.

The somewhat poorly drained Bearden soils are on toe slopes. Slopes are less than 2 percent. Typically, the surface layer is dark gray and gray, calcareous silt loam. The next layer is gray, calcareous silt loam. The subsoil is light gray, calcareous silt loam. The underlying material is pale yellow, calcareous silt loam.

Minor in this association are Colvin, Great Bend, Huffton, Putney, and Rondell soils. The poorly drained and very poorly drained Colvin soils are on the lower toe slopes. The well drained Great Bend, Huffton, and Putney soils are on back slopes. Great Bend soils are not dark to a depth of more than 16 inches. Huffton and Putney soils have salts near the surface. The moderately well drained Rondell soils are slightly higher on the landscape than the Bearden soils.

About 80 percent of this association is cropland. Corn, wheat, oats, barley, soybeans, and alfalfa are the main crops. Conserving moisture in the Beotia soils and controlling wind erosion and improving fertility on the Bearden soils are the main management concerns.

This association is suited to cultivated crops, tame pasture and hay, range, and openland and rangeland wildlife habitat. It is suited to building site development, but a moderate shrink-swell potential in both soils and wetness in the Bearden soils are limitations. The Beotia soils are suited to septic tank absorption fields, but restricted permeability is a limitation. The Bearden soils are generally unsuited to septic tank absorption fields because of the wetness.

7. Great Bend-Beotia Association

Well drained, level to moderately sloping, silty soils on glacial lake plains

This association is on lake plains. It is characterized by flats and slight rises interrupted by a few drainage channels.

This association makes up about 21 percent of the county. It is about 35 percent Great Bend soils, 25 percent Beotia soils, and 40 percent minor soils (fig. 3).

The Great Bend soils are on back slopes. Slopes range from 0 to 9 percent. Typically, the surface layer is grayish brown silt loam. The subsoil is grayish brown and pale yellow silty clay loam and silt loam. It is calcareous in the lower part. The underlying material is light olive brown, light gray, and white, varved, calcareous silt loam.

The Beotia soils are on foot slopes. Slopes range from 0 to 6 percent. Typically, the surface layer is dark gray silt loam. The subsoil is grayish brown silty clay loam and silt loam in the upper part and pale yellow, calcareous silt loam in the lower part. The underlying material is pale yellow, varved, calcareous silt loam.

Minor in this association are Aberdeen, Bearden, Eckman, Gardena, Harmony, Huffton, Putney, Tonka, Winship, and Zell soils. Aberdeen and Harmony soils contain more clay in the subsoil than the major soils. They are on the lower foot slopes. The somewhat poorly drained Bearden soils are on toe slopes. They have free carbonates at the surface. Eckman and Gardena soils contain more silt and less clay than the major soils. They are in positions on the landscape similar to those of the Great Bend soils. The well drained Huffton and Zell soils are on shoulder slopes. They have free carbonates at the surface. Also, Huffton

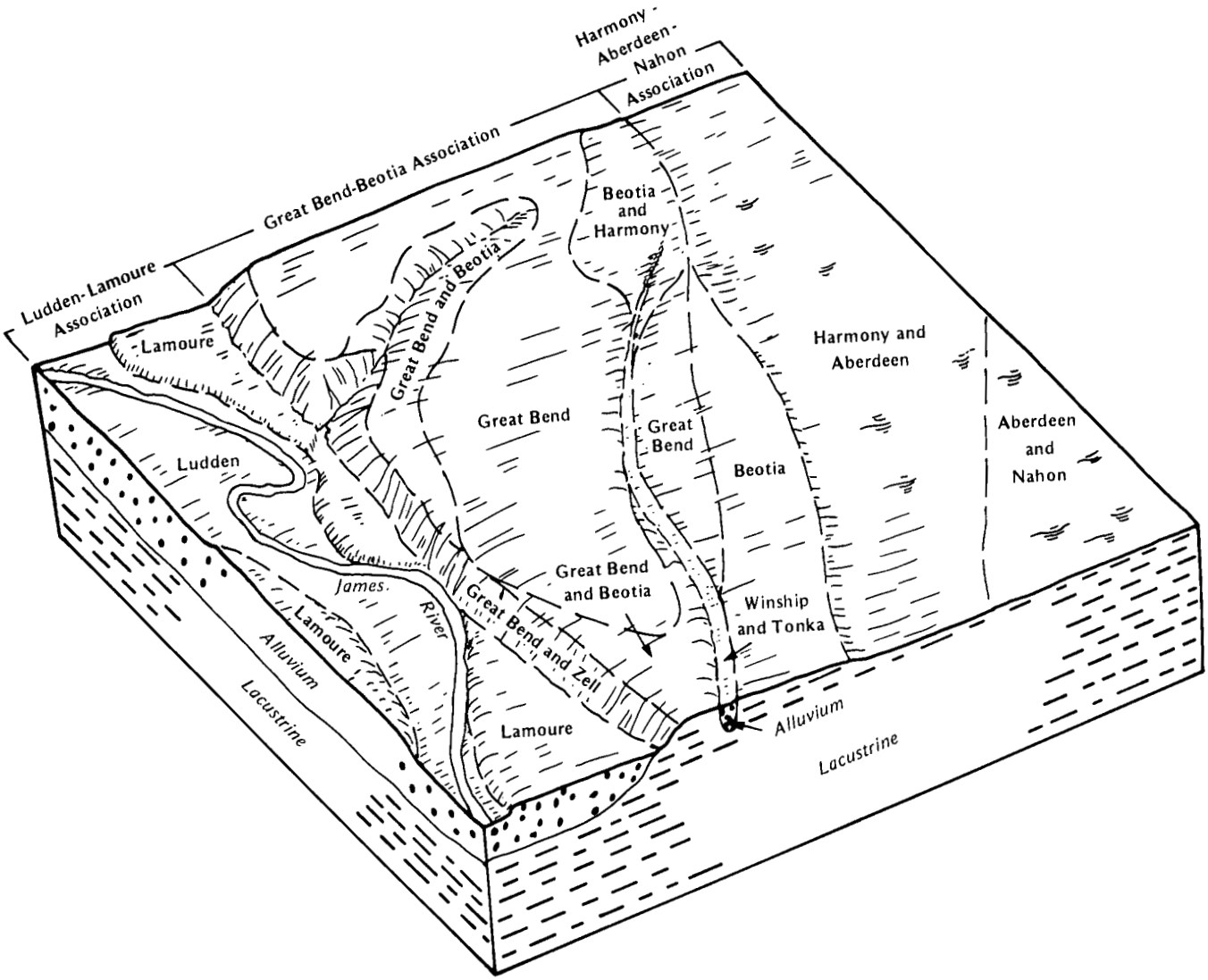

Figure 3.—Typical pattern of soils and parent material in the Great Bend-Beotia, Harmony-Aberdeen-Nahon, and Ludden-Lamoure associations.

soils have salts near the surface. Putney soils have more salts within a depth of 20 inches than the major soils. They are in positions on the landscape similar to those of the Great Bend soils. The poorly drained Tonka soils are in basins. The somewhat poorly drained Winship soils are on toe slopes.

About 90 percent of this association is cropland. Corn, wheat, oats, alfalfa, and soybeans are the main crops. Measures that control erosion and conserve moisture are the main management needs.

This association is suited to cultivated crops, tame pasture and hay, range, and openland and rangeland wildlife habitat. It is suited to building site development, but a moderate shrink-swell potential is a limitation in the Beotia soils. The association is suited to septic tank absorption fields, but restricted permeability is a limitation.

Level and Nearly Level, Silty Soils on Glacial Lake Plains and Flood Plains

These soils formed in glaciolacustrine deposits and alluvium. They make up about 11 percent of the county. About 85 percent of the acreage is cropland. Wheat, barley, corn, oats, sunflowers, soybeans, and alfalfa are the main crops.

8. Harmony-Aberdeen-Nahon Association

Moderately well drained, level and nearly level, silty soils and moderately well drained and somewhat poorly drained, level and nearly level, sodium-affected, silty soils; on glacial lake plains

This association is on glacial lake plains characterized by broad flats and many microlows.

This association makes up about 10 percent of the county. It is about 35 percent Harmony soils, 25 percent Aberdeen soils, 20 percent Nahon soils, and 20 percent minor soils (fig. 3).

The moderately well drained Harmony soils are on the lower back slopes. Slopes are 0 to 2 percent. Typically, the surface layer is dark gray silty clay loam. The subsoil is dark gray, grayish brown, and light brownish gray silty clay loam, silty clay, and calcareous clay loam. The underlying material is light gray, varved, calcareous loam.

The moderately well drained Aberdeen soils are on the upper foot slopes. Slopes are 0 to 2 percent. Typically, the surface layer is dark gray silty clay loam. The next layer is gray silty clay loam. The subsoil is dark gray silty clay in the upper part and light gray and light brownish gray, calcareous silty clay loam in the lower part. The underlying material is light gray and pale yellow, calcareous silt loam. It is varved in the lower part.

The somewhat poorly drained and moderately well drained Nahon soils are on the lower foot slopes and in microlows. Slopes are 0 to 2 percent. Typically, the surface layer is dark gray silty clay loam. The subsurface layer is gray silt loam. The upper part of the subsoil is gray and grayish brown silty clay and silty clay loam. The lower part is light brownish gray and pale yellow, calcareous silty clay loam that has nests of salt. The underlying material is white and grayish brown, varved, calcareous silty clay loam and clay.

Minor in this association are Bearden, Beotia, Colvin, Exline, Great Bend, Huffton, Putney, Tonka, Winship, and Zell soils. Bearden and Colvin soils have free carbonates at the surface. They are on toe slopes. Beotia, Great Bend, Huffton, Putney, Winship, and Zell soils contain more silt and less clay than the major soils. Beotia soils are in positions on the landscape similar to those of the Harmony soils. The well drained Great Bend and Putney soils are on back slopes. The well drained Huffton and Zell soils are on shoulder slopes. They have free carbonates at the surface. Winship soils are on toe slopes. Exline soils have salts within a depth of 16 inches. They are in positions on the landscape similar to those of the Nahon soils. The poorly drained Tonka soils are in basins.

About 80 percent of this association is cropland. Corn, wheat, oats, barley, soybeans, and alfalfa are the main crops. Conserving moisture, increasing the rate of water intake, and improving tilth are the main management concerns.

This association is suited to cultivated crops, tame pasture and hay, range, and openland and rangeland wildlife habitat. The sodium-affected subsoil in the Aberdeen and Nahon soils is a limitation. The association is suited to building site development and septic tank absorption fields, but a high shrink-swell potential is a limitation on building sites and restricted permeability is a limitation in septic tank absorption fields.

9. Aberdeen-Exline-Harriet Association

Moderately well drained to poorly drained, level and nearly level, sodium-affected, silty soils on glacial lake plains and flood plains

This association is on glacial lake plains and flood plains characterized by broad flats interrupted by many microlows.

This association makes up about 1 percent of the county. It is about 30 percent Aberdeen soils, 20 percent Exline soils, 15 percent Harriet soils, and 35 percent minor soils (fig. 4).

The moderately well drained Aberdeen soils are on foot slopes. Slopes are 0 to 2 percent. Typically, the surface layer is dark gray silty clay loam. The next layer is gray silty clay loam. The subsoil is dark gray silty clay in the upper part and light gray and light brownish gray, calcareous silty clay loam in the lower part. The underlying material is light gray and pale yellow, calcareous silt loam. It is varved in the lower part.

The moderately well drained and somewhat poorly drained Exline soils are on toe slopes. Slopes are less than 2 percent. Typically, the surface layer is dark gray silt loam. The subsurface layer is gray silt loam. The upper part of the subsoil is dark gray clay. The next part is dark gray, gray, and light brownish gray clay that has nests of salt. The lower part is light brownish gray silty clay loam. The subsoil is calcareous below a depth of 11 inches. The underlying material is light gray, varved, calcareous silty clay loam.

The poorly drained Harriet soils are on flood plains. Slopes are less than 1 percent. Typically, the surface layer is gray silt loam. The subsoil is dark gray and gray, calcareous clay loam. It has nests of salt in the lower part. The underlying material is gray, calcareous clay loam.

The most extensive minor soils in this association are the Harmony and Nahon soils. Harmony soils are on the lower back slopes and the upper foot slopes. They do not have a sodium-affected subsoil. Nahon soils are

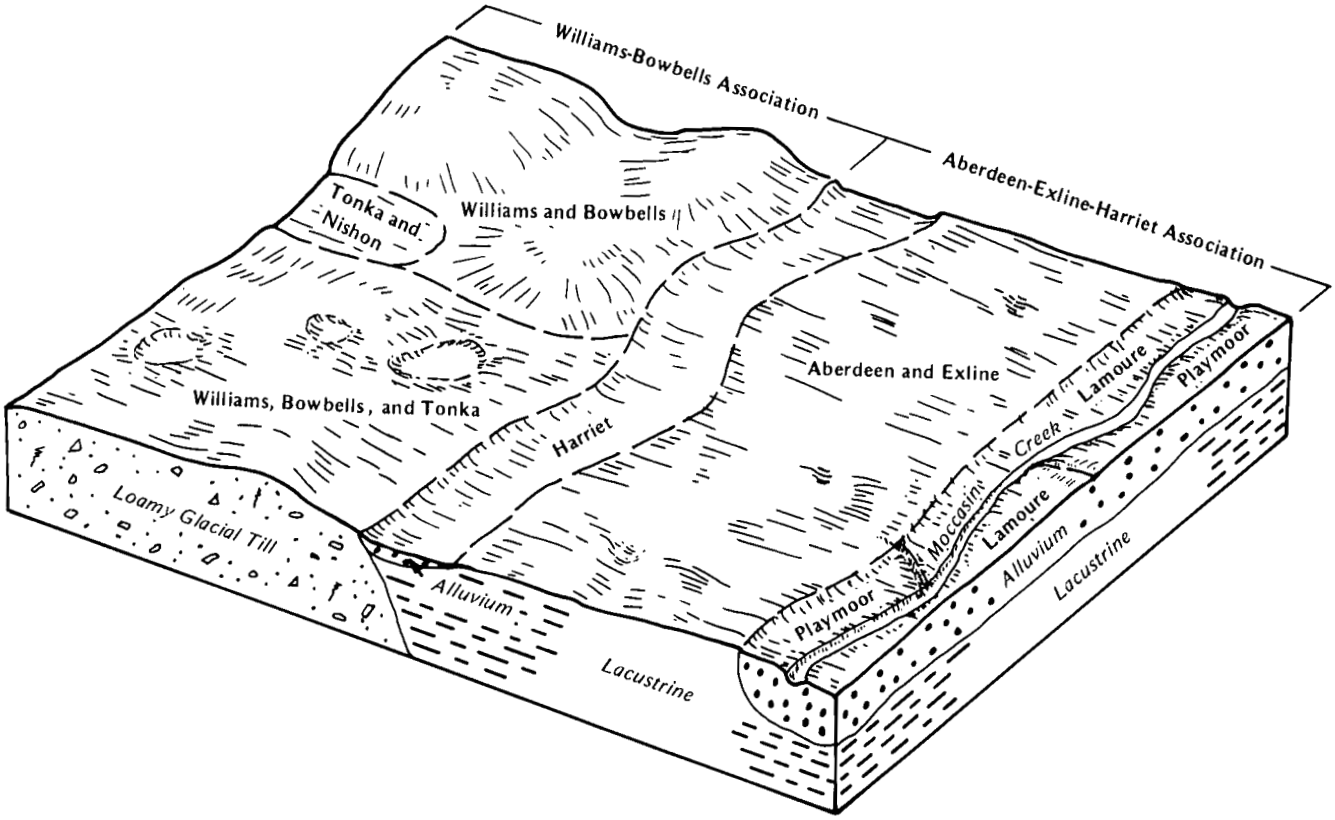

Figure 4.—Typical pattern of soils and parent material in the Aberdeen-Exline-Harriet and Williams-Bowbells associations.

on the lower foot slopes. They do not have salts within a depth of 16 inches. Less extensive are the Bearden, Great Bend, LaDelle, Lamoure, Playmoor, Putney, Ranslo, and Tonka soils. Bearden, Great Bend, LaDelle, Lamoure, Playmoor, Putney, and Tonka soils do not have a sodium-affected subsoil. The somewhat poorly drained Bearden soils are on toe slopes between and around the edges of basins. They have free carbonates at the surface. The well drained Great Bend and Putney soils are on back slopes. The moderately well drained LaDelle and somewhat poorly drained Ranslo soils formed in alluvium. They are slightly higher on the landscape than the Harriet soils. The somewhat poorly drained and poorly drained Lamoure soils and the poorly drained Playmoor soils are in positions on the landscape similar to those of the Harriet soils. They formed in alluvium. The poorly drained Tonka soils are in basins.

About 60 percent of this association is range. Increasing the rate of water intake, improving tilth, and conserving moisture are the main management concerns if these soils are used for crops.

The Aberdeen soils are suited to cultivated crops, tame pasture and hay, range, and openland and rangeland wildlife habitat, but the dense, sodium-affected subsoil is a limitation. The Exline and Harriet soils generally are unsuited to cultivated crops and openland wildlife habitat because of wetness and the dense, sodium-affected subsoil. They are suited to range and to rangeland wildlife habitat, but the dense, sodium-affected subsoil and the wetness are limitations. The Exline soils generally are unsuited to tame pasture and hay because of the dense, sodium-affected subsoil. The Harriet soils are suited to tame pasture and hay, but the high content of salts is a limitation.

The Aberdeen and Exline soils are suited to building site development, but a high shrink-swell potential is a limitation. Wetness also is a limitation in the Exline soils. The Aberdeen and Exline soils are suited to septic tank absorption fields, but restricted permeability is a limitation. Wetness also is a limitation in the Exline soils. The Harriet soils are generally unsuited to building site development and septic tank absorption fields because of the wetness and flooding.

Level to Moderately Sloping, Silty Soils on Till Plains and Moraines

These soils formed in silty material over glacial till. They are dominantly level to moderately sloping but are strongly sloping along some drainageways. They make up about 2 percent of the county. About 85 percent of the acreage is cropland. Corn, wheat, oats, barley, soybeans, and alfalfa are the main crops.

10. Kranzburg-Brookings Association

Well drained and moderately well drained, level to moderately sloping, silty soils on till plains and moraines

This association is on glacial till uplands mantled with silty material. The landscape is characterized by flats and slight rises. Many drainageways cross the association, and the drainage pattern is well defined.

This association makes up about 2 percent of the county. It is about 35 percent Kranzburg soils, 30 percent Brookings soils, and 35 percent minor soils.

The well drained Kranzburg soils are on back slopes. Slopes range from 0 to 9 percent. Typically, the surface layer is dark gray silt loam. The subsoil is dark grayish brown and brown silt loam in the upper part and light brownish gray, calcareous clay loam in the lower part. The underlying material is pale yellow and light gray, calcareous clay loam.

The moderately well drained Brookings soils are on foot slopes. Slopes are 0 to 2 percent. Typically, the surface layer is dark gray silt loam. The upper part of the subsoil is dark grayish brown and light olive brown silt loam. The lower part is light yellowish brown silt loam and grayish brown clay loam. It is calcareous. The underlying material is light brownish gray, calcareous clay loam.

Minor in this association are Aastad, Barnes, Buse, Cavour, Cresbard, Lamoure, Playmoor, and Tonka soils. Aastad, Barnes, and Buse soils contain more sand and less silt in the subsoil than the major soils. Aastad soils are in positions on the landscape similar to those of the Brookings soils. Barnes and Buse soils are in positions on the landscape similar to those of the Kranzburg soils. Cavour and Cresbard soils have a sodium-affected subsoil. They are on the lower foot slopes. The poorly drained Lamoure and Playmoor soils are on flood plains. The poorly drained Tonka soils are in basins.

About 85 percent of this association is cropland. Corn, wheat, oats, barley, soybeans, and alfalfa are the main crops. The steeper soils along drainageways support native grasses and are used for grazing. Measures that control erosion, conserve moisture, and maintain fertility are the main management needs.

This association is suited to cultivated crops, tame pasture and hay, range, and openland and rangeland wildlife habitat. The Kranzburg soils are suited to building site development, but a moderate shrink-swell potential is a limitation. They are suited to septic tank absorption fields, but restricted permeability is a limitation. The Brookings soils are generally unsuited to building site development and septic tank absorption fields because they are subject to flooding.

Level to Rolling, Loamy Soils on Till Plains and Moraines

These soils formed in glacial till. They are dominantly level to rolling but are hilly along some drainageways. They make up about 44 percent of the county. About 66 percent of the acreage is cropland. Wheat, oats, barley, corn, sunflowers, and alfalfa are the main crops. The nearly level to gently rolling soils are cultivated. Some nearly level areas of sodium-affected soils and areas of rolling and hilly soils support native grasses and are used for pasture or hay.

11. Forman-Aastad-Cavour Association

Well drained and moderately well drained, level to gently rolling, loamy soils and moderately well drained, level to undulating, sodium-affected, loamy soils; on till plains and moraines

This association is on till plains characterized by rises interrupted by swales and drainageways. Slopes are long and gently rolling in some areas and short and undulating in other areas. The drainage pattern is well defined.

This association makes up about 1 percent of the county. It is about 25 percent Forman soils, 18 percent Aastad soils, 17 percent Cavour soils, and 40 percent minor soils.

The well drained Forman soils are on back slopes and summits. Slopes range from 0 to 9 percent. Typically, the surface layer is dark gray loam. The subsoil is grayish brown clay loam. It is calcareous in the lower part. The underlying material is light yellowish brown and pale yellow, calcareous clay loam.

The moderately well drained Aastad soils are on foot slopes. Slopes are 0 to 2 percent. Typically, the surface layer is dark gray loam. The subsoil is clay loam. The upper part is dark grayish brown and grayish brown, and the lower part is light brownish gray and light yellowish brown and is calcareous. The underlying material is light yellowish brown, calcareous clay loam.

The moderately well drained Cavour soils are on the lower foot slopes. Slopes range from 0 to 6 percent. Typically, the surface layer is dark gray loam. The

subsurface layer is gray loam. The upper part of the subsoil is dark grayish brown clay, and the lower part is grayish brown, calcareous clay loam that has nests of salt. The underlying material is light brownish gray and light gray, calcareous clay loam.

The most extensive minor soils in this association are the Ferney and Peever soils. Ferney soils have a sodium-affected subsoil. They are in positions on the landscape similar to those of the Cavour soils. Peever soils contain more clay in the subsoil than the major soils. They are in positions on the landscape similar to those of the Forman soils. Less extensive are the Barnes, Buse, Cresbard, and Tonka soils. Barnes soils contain less clay in the subsoil than the major soils. They are in positions on the landscape similar to those of the Forman soils. Buse soils have carbonates within a depth of 10 inches. They are on shoulder slopes. Cresbard soils have a sodium-affected subsoil. They are in positions on the landscape similar to those of the Aastad soils. The poorly drained Tonka soils are in basins.

About 60 percent of this association is cropland. Wheat, oats, barley, corn, and alfalfa are the main crops. Measures that conserve moisture and control erosion are the main management needs. Increasing the rate of water intake and improving tilth also are management concerns in areas of the Cavour soils.

This association is suited to cultivated crops, tame pasture and hay, range, and rangeland and openland wildlife habitat. The sodium-affected subsoil in the Cavour soils is a limitation. The Forman and Cavour soils are suited to building site development, but a moderate or high shrink-swell potential is a limitation. They are suited to septic tank absorption fields, but restricted permeability is a limitation. The Aastad soils generally are unsuited to building site development and septic tank absorption fields because they are subject to flooding.

12. Barnes-Svea Association

Well drained and moderately well drained, level to rolling, loamy soils on till plains and moraines

This association is on till plains and moraines characterized by undulating slopes and basins. Slopes generally are short. They are mainly undulating, but in some areas they are nearly level and in others are gently rolling to hilly. The drainage pattern is poorly defined in most areas.

This association makes up about 22 percent of the soils in the county. It is about 50 percent Barnes soils, 20 percent Svea soils, and 30 percent minor soils (fig. 5).

The well drained Barnes soils are on back slopes. Slopes range from 0 to 15 percent. Typically, the surface layer is dark gray loam. The subsoil is brown clay loam and pale brown loam in the upper part and light brownish gray, calcareous loam in the lower part. The underlying material is light brownish gray, calcareous loam.

The moderately well drained Svea soils are on foot slopes. Slopes are 0 to 2 percent. Typically, the surface layer is dark gray loam. The subsoil is grayish brown loam in the upper part and pale yellow, calcareous clay loam in the lower part. The underlying material is light yellowish brown, calcareous clay loam.

Minor in this association are Buse, Cavour, Cresbard, Fordville, Hamerly, Harriet, LaDelle, Nishon, Parnell, Ranslo, Tonka, and Vallers soils. The well drained Buse soils are on shoulder slopes. They have carbonates within a depth of 10 inches. The moderately well drained Cavour and Cresbard soils are in positions on the landscape similar to those of the Svea soils. They have a sodium-affected subsoil. Fordville soils are underlain by gravelly sand. They are on outwash plains. The somewhat poorly drained, calcareous Hamerly soils are on toe slopes between and around the edges of basins. The poorly drained Harriet, moderately well drained LaDelle, and somewhat poorly drained Ranslo soils are on flood plains. The very poorly drained Parnell soils are in basins. The poorly drained Nishon and Tonka soils are in basins. The poorly drained, calcareous Vallers soils are on the lower toe slopes.

About 65 percent of this association is cropland. Wheat, corn, barley, sunflowers, and alfalfa are the main crops. Some areas are being irrigated with center-pivot systems. Measures that conserve moisture and control erosion are the main management needs.

This association is suited to cultivated crops, tame pasture and hay, range, and rangeland and openland wildlife habitat. The Barnes soils are suited to most kinds of building site development, but a moderate shrink-swell potential is a limitation. They are suited to septic tank absorption fields, but restricted permeability is a limitation. The Svea soils generally are unsuited to building site development and septic tank absorption fields because they are subject to flooding.

13. Williams-Bowbells Association

Well drained and moderately well drained, level to rolling, loamy soils on till plains and moraines

This association is on till plains and moraines characterized by rises interrupted by narrow swales and many basins. Slopes generally are short. They are mainly undulating, but in some areas they are nearly level and in others are gently rolling to hilly. The drainage pattern is poorly defined in most areas.

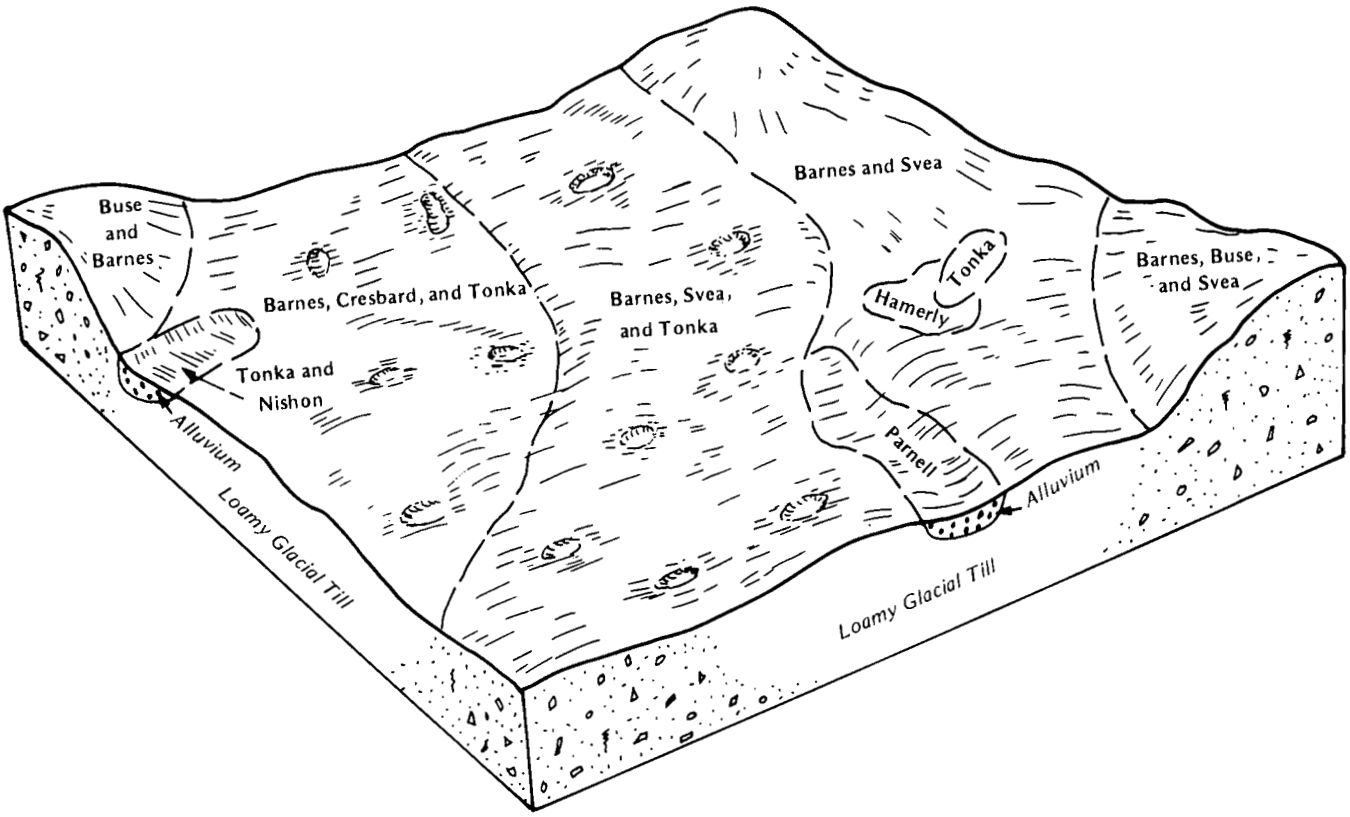

Figure 5.—Typical pattern of soils and parent material in the Barnes-Svea association.

This association makes up about 4 percent of the county. It is about 50 percent Williams soils, 20 percent Bowbells soils, and 30 percent minor soils (fig. 4).

The well drained Williams soils are on back slopes. Slopes range from 0 to 15 percent. Typically, the surface layer is dark grayish brown loam. The subsoil is brown, grayish brown, light brownish gray, and light gray clay loam. It is calcareous in the lower part. The underlying material is light brownish gray, calcareous clay loam.

The moderately well drained Bowbells soils are on foot slopes. Slopes range from 0 to 3 percent. Typically, the surface layer is dark gray loam. The subsoil is clay loam. It is brown and pale brown in the upper part and light gray and calcareous in the lower part. The underlying material is light gray, calcareous clay loam.

Minor in this association are Cavour, Cresbard, Hamerly, Niobell, Nishon, Parnell, Renshaw, Tonka, and Vida soils. Cavour, Cresbard, and Niobell soils have a sodium-affected subsoil. Cavour soils are on the lower foot slopes. Cresbard and Niobell soils are in positions on the landscape similar to those of the Bowbells soils. The somewhat poorly drained Hamerly soils are on toe slopes between and around the edges of basins. They have free carbonates at the surface. The poorly drained Nishon and Tonka soils and the very poorly drained Parnell soils are in basins. Renshaw soils are underlain by gravelly sand. They are on outwash plains. Vida soils are on the upper back slopes. They have free carbonates within a depth of 10 inches.

About 65 percent of this association is cropland. Corn, wheat, oats, barley, sunflowers, and alfalfa are the main crops. Measures that control erosion and conserve moisture are the main management needs.

This association is suited to cultivated crops, tame pasture and hay, range, and openland and rangeland wildlife habitat. The Williams soils are suited to most kinds of building site development, but a moderate shrink-swell potential is a limitation. They are suited to septic tank absorption fields, but restricted permeability is a limitation. The Bowbells soils generally are unsuited to building site development and septic tank absorption fields because they are subject to flooding.

14. Niobell-Noonan-Williams Association

Moderately well drained, nearly level to gently sloping, sodium-affected, loamy soils and well drained, nearly level to undulating, loamy soils; on till plains and moraines

This association is on till plains and moraines. It is characterized by flats and rises interrupted by swells and swales. The relief is dominantly nearly level to undulating but is steeper along the larger drainageways. The drainage system is poorly defined. Some small drainageways terminate in basins.

This association makes up about 17 percent of the county. It is about 35 percent Niobell soils, 20 percent Noonan soils, 15 percent Williams soils, and 30 percent minor soils (fig. 6).

The moderately well drained Niobell soils are on the upper foot slopes. Slopes range from 0 to 6 percent. Typically, the surface layer is dark grayish brown loam. The subsurface layer is grayish brown loam. The next layer is dark grayish brown clay loam. The subsoil is grayish brown, yellowish brown, and light yellowish brown clay loam. In the lower part it is calcareous and has nests of salt. The underlying material is pale yellow, calcareous clay loam.

The moderately well drained Noonan soils are on the lower foot slopes. Slopes range from 0 to 4 percent. Typically, the surface layer is dark grayish brown loam. The subsurface layer is grayish brown loam. The subsoil is clay loam. The upper part is dark grayish brown, the next part is light olive brown and has nests of salt, and the lower part is light brownish gray and calcareous. The underlying material is light brownish gray, calcareous clay loam.

The well drained Williams soils are on back slopes and summits. Slopes range from 0 to 6 percent. Typically, the surface layer is dark grayish brown loam. The subsoil is brown, grayish brown, light brownish gray, and light gray clay loam. It is calcareous in the lower part. The underlying material is light brownish gray, calcareous clay loam.

The most extensive minor soils in this association are the Harriet, Miranda, and Ranslo soils. The poorly drained Harriet and somewhat poorly drained Ranslo soils are on flood plains. The moderately well drained and somewhat poorly drained Miranda soils are in the slightly lower positions on the landscape. They have salts within a depth of 16 inches. Less extensive are the Brantford Variant, Ferney, Heil, Kloten, Letcher, Nishon, Tally, Tonka, and Zahl soils. The well drained Brantford Variant soils are on terraces. They are underlain by gravelly sand. The poorly drained Heil, Nishon, and Tonka soils are in shallow basins. The somewhat poorly drained Ferney soils are in the slightly lower positions on the landscape. They have salts within a depth of 16 inches. The well drained Kloten, Tally, and Zahl soils are on the higher parts of the landscape. The moderately well drained and somewhat poorly drained Letcher soils are in positions on the landscape similar to those of the Noonan soils. They have less clay in the subsoil than the Noonan soils. Brantford Variant, Kloten, Nishon, Tally, Tonka, and Zahl soils do not have a sodium-affected subsoil.

About 70 percent of this association is cropland, about half of which is used for tame pasture or hay. Wheat, barley, oats, and alfalfa are the main crops. Measures that increase the rate of water intake, conserve moisture, and improve tilth are the main management needs.

This association is suited to cultivated crops, tame pasture and hay, range, and openland and rangeland wildlife habitat, but the dense, compact subsoil in the Niobell and Noonan soils is a limitation. The association is suited to most kinds of building site development and septic tank absorption fields, but a moderate or high shrink-swell potential is a limitation on building sites and restricted permeability is a limitation in septic tank absorption fields.

Level and Nearly Level, Clayey and Silty Soils on Flood Plains and Outwash Plains

These soils make up about 6 percent of the county. About 35 percent of the acreage is cropland. Corn, wheat, barley, rye, sunflowers, and alfalfa are the main crops. Farming commonly is delayed by wetness.

15. Ludden-Lamoure Association

Poorly drained and somewhat poorly drained, level and nearly level, clayey and silty soils on flood plains

This association is on broad flood plains along the James River. The smooth areas are dissected by the river channel and by meander scars. Narrow, low ridges and oxbows are in a few areas. The soils are flooded for short to long periods during snowmelt and after heavy rains. The drainage pattern is poorly defined in all areas, except for those near the channel.

This association makes up about 3 percent of the county. It is about 55 percent Ludden soils, 25 percent Lamoure soils, and 20 percent minor soils (fig. 3).

The poorly drained Ludden soils are on low flood plains. Slopes are less than 1 percent. Typically, the surface layer and subsoil are dark gray, calcareous silty clay. The underlying material is gray, calcareous silty clay and clay loam.

The somewhat poorly drained and poorly drained Lamoure soils are on high flood plains. Slopes are less than 2 percent. Typically, the surface layer is dark gray,

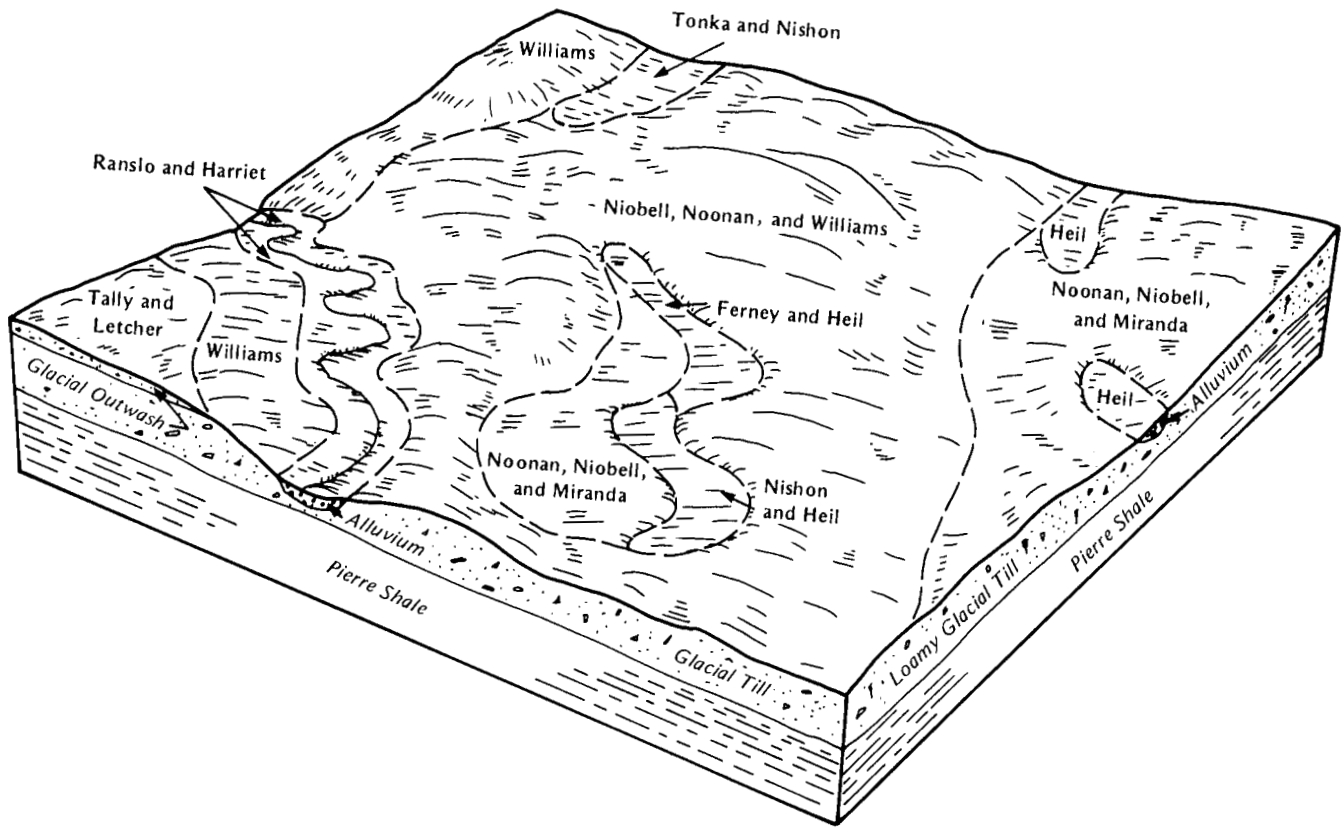

Figure 6.—Typical pattern of soils and parent material in the Niobell-Noonan-Williams association.

calcareous silty clay loam. The next layer is gray, calcareous silty clay loam. The underlying material is gray and dark gray, calcareous silty clay loam and white, calcareous loamy very fine sand.

Minor in this association are Colvin, Dovray, Playmoor, and Ryan soils. Colvin soils formed in glaciolacustrine sediments on toe slopes. Dovray soils are deeper to carbonates than the major soils. They are in the slightly lower positions on the landscape. Playmoor soils have salts near the surface. They are in positions on the landscape similar to those of the Lamoure soils. Ryan soils have a sodium-affected subsoil. They are in the slightly lower positions on the landscape.

About 70 percent of this association is cropland. Corn, wheat, barley, rye, sunflowers, and alfalfa are the main crops. Some areas support native grasses and are used for grazing or hay. Reducing wetness is the main concern in managing the major soils for crops. Improving tilth and increasing the rate of water intake are additional concerns.

This association is suited to cultivated crops, tame pasture and hay, and openland wildlife habitat, but the flooding is a hazard. The major soils are suited to range and to rangeland wildlife habitat. They are generally unsuited to building site development and septic tank absorption fields because of the flooding and the wetness.

16. Ludden, Ponded, Association

Very poorly drained, level, clayey soils on flood plains

This association is on broad flood plains along the James River. It is frequently flooded and is ponded for long periods. In some areas it is ponded throughout the year. It is a major part of the Sand Lake National Wildlife Refuge. Several dams and dikes, which are used to regulate the ponding, have created scattered open water areas. Slopes are less than 1 percent.

This association makes up about 1 percent of the county. It is about 45 percent ponded Ludden soils, 30 percent areas of open water, and 25 percent minor soils.

Typically, the surface layer and subsoil of the Ludden soils are dark gray, calcareous silty clay. The underlying material is gray, calcareous silty clay and clay loam.

Minor in this association are Arveson, Borup, Colvin, Dovray, Fossum, Hamar, Lamoure, Playmoor, and Ulen soils. Arveson and Borup soils contain more sand and silt than the Ludden soils. They are in the slightly higher positions on the landscape. Colvin soils contain less clay than the Ludden soils. They are on toe slopes adjacent to the flood plains. Dovray soils are deeper to carbonates than the Ludden soils. They are in old channels and in the lower areas. Fossum, Hamar, and Ulen soils contain more sand than the Ludden soils. Fossum and Hamar soils are on toe slopes along the edges of the flood plains. The moderately well drained and somewhat poorly drained Ulen soils are on toe slopes. Lamoure and Playmoor soils are in the slightly higher positions on the landscape. They contain less clay than the Ludden soils. Also, Playmoor soils have salts near the surface.

About 70 percent of this association supports wetland vegetation and is used for wildlife habitat. Geese, ducks, and other waterfowl use areas of the association as resting and feeding sites during migration. Cattails, rushes, and sedges are the main wetland plants.

17. LaDelle-Aberdeen, Sandy Substratum, Association

Moderately well drained, nearly level, silty soils and moderately well drained, level and nearly level, sodium-affected, silty soils; on flood plains and outwash plains

This association is on flood plains and outwash plains characterized by broad flats.

This association makes up about 1 percent of the county. It is about 40 percent LaDelle soils, 20 percent Aberdeen soils that have a sandy substratum, and 40 percent minor soils.

The LaDelle soils are on high flood plains. Slopes are 0 to 2 percent. Typically, the surface layer is dark gray silt loam. The subsoil is dark gray and gray, calcareous silt loam. The underlying material is grayish brown, calcareous silt loam.

The Aberdeen soils are on foot slopes adjacent to the flood plains. Slopes are 0 to 2 percent. Typically, the surface layer is dark gray silty clay loam. The next layer is gray silty clay loam. The subsoil is dark gray silty clay in the upper part and light gray and light brownish gray, calcareous silty clay loam in the lower part. The upper part of the underlying material is light gray, calcareous silt loam. The lower part is light brownish gray fine sand.

The most extensive minor soils in this association are the Embden and Harmony Variant soils and the Nahon soils that have a sandy substratum. Embden soils contain more sand in the subsoil than the major soils. They are on the upper foot slopes. Harmony Variant soils are on the upper foot slopes. They do not have a sodium-affected subsoil and have fine sand at a depth of 20 to 40 inches. Nahon soils are slightly lower on the landscape than the Aberdeen soils. They have a sodium-affected subsoil that has columnar structure. Less extensive are the Exline soils that have a sandy substratum and the Fordville, Ludden, and Spottswood soils. The somewhat poorly drained Exline soils are slightly lower on the landscape than the Aberdeen soils. They have visible salts within a depth of 16 inches. Fordville and Spottswood soils have gravelly sand at a depth of 20 to 40 inches. They are on outwash plains. The poorly drained Ludden soils are in the slightly lower positions on the landscape.

About 85 percent of this association is cropland. Wheat, corn, oats, barley, and alfalfa are the main crops. Conserving moisture, increasing the rate of water intake, and improving tilth are the main management concerns.

This association is suited to cultivated crops, tame pasture and hay, range, and openland and rangeland wildlife habitat. The sodium-affected subsoil in the Aberdeen soils is a limitation. The association is suited to building site development, but flooding on the LaDelle soils and a high shrink-swell potential in the Aberdeen soils are limitations. The major soils are suited to septic tank absorption fields, but flooding on the LaDelle soils and wetness and restricted permeability in both soils are limitations.

18. Ludden-Ryan Association

Poorly drained, level, clayey soils and poorly drained, level, sodium-affected, silty soils; on flood plains

This association is on flood plains characterized by broad flats that have many microlows. It is flooded for brief to long periods during snowmelt and after heavy rains. The drainage pattern is poorly defined.

This association makes up about 1 percent of the county. It is about 55 percent Ludden soils, 25 percent Ryan soils, and 20 percent minor soils.

The Ludden soils are on low flood plains. Slopes are less than 1 percent. Typically, the surface layer is dark gray, calcareous silty clay. The subsoil is also dark gray, calcareous silty clay. The underlying material is gray, calcareous silty clay and clay loam.

The Ryan soils are in microlows on low flood plains. Slopes are less than 1 percent. Typically, the surface layer is gray silty clay loam. The subsoil is dark gray and gray clay. In the lower part it is calcareous and has nests of salt. The underlying material is gray, calcareous silty clay loam.

Minor in this association are Dovray, Lamoure, Playmoor, and Ranslo soils. Dovray soils are deeper to

carbonates than the Ludden and Ryan soils. They are in the lower positions on the landscape. Lamoure and Playmoor soils contain less clay than the major soils. They are in the slightly higher positions on the landscape. Ranslo soils have a sodium-affected subsoil and have a surface layer that is thicker than that of the Ryan soils. They are in the slightly higher positions on the landscape.

About 60 percent of this association is cropland. Wheat, barley, rye, and alfalfa are the main crops. Some areas support native grasses and are used for grazing or hay. Reducing wetness is the main concern in managing the major soils for crops. Improving tilth and increasing the rate of water intake are additional concerns.

This association is suited to cultivated crops, tame pasture and hay, and openland wildlife habitat, but the flooding on both soils and the sodium-affected subsoil in the Ryan soils are limitations. The association is suited to range and to rangeland wildlife habitat, but the sodium-affected subsoil in the Ryan soils is a limitation. The major soils are generally unsuited to building site development and septic tank absorption fields because of the flooding and the wetness.

Detailed Soil Map Units

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

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

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

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

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Great Bend silt loam, 0 to 2 percent slopes, is a phase of the Great Bend 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. Barnes-Svea-Tonka complex, 0 to 3 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, gravel, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The "Glossary" defines many of the terms used in describing the soils.

Soil Descriptions

Ab—Aberdeen-Nahon silty clay loams. These deep, level and nearly level soils are on glacial lake plains. The moderately well drained Aberdeen soil is on back slopes. The moderately well drained and somewhat poorly drained Nahon soil is on the lower back slopes and upper foot slopes. Areas are irregular in shape and range from 20 to more than 500 acres in size. They are 45 to 55 percent Aberdeen soil and 25 to 35 percent Nahon soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Aberdeen soil is dark gray silty clay loam about 8 inches thick. Below this is a mixed layer about 3 inches thick. This layer is gray silty clay loam that has gray silt coatings on faces of peds. The subsoil is about 27 inches thick. The upper part is dark gray, firm silty clay. The lower part is light gray and light brownish gray, firm, calcareous silty clay loam that has nests of gypsum and other salts. The upper part of the underlying material is light gray, calcareous silt loam. The lower part to a depth of 60 inches is pale yellow, calcareous silt loam varved with

silty clay and very fine sandy loam.

Typically, the surface layer of the Nahon soil is dark gray silty clay loam about 6 inches thick. The subsurface layer is gray silt loam about 3 inches thick. The subsoil is about 28 inches thick. The upper part is gray, firm silty clay and grayish brown, firm silty clay loam. The lower part is light brownish gray and pale yellow, firm and friable silty clay loam. It is calcareous and has nests of gypsum and other salts. The underlying material to a depth of 60 inches is white and grayish brown, calcareous silty clay loam and clay varved with very fine sandy loam and silty clay.

Included with these soils in mapping are small areas of Beotia, Exline, and Harmony soils. These included soils make up less than 20 percent of this map unit. Beotia and Harmony soils are slightly higher on the landscape than the Aberdeen soil. Beotia soils contain less clay and more silt in the subsoil than the Aberdeen and Nahon soils. Harmony soils do not have a sodium-affected subsoil. Exline soils have visible salt crystals within a depth of 16 inches. They are slightly lower on the landscape than the Nahon soil.

The content of organic matter is moderate in the Aberdeen and Nahon soils, and fertility is medium. Both soils have a sodium-affected subsoil. Tilth is fair in the Aberdeen soil and poor in the Nahon soil. Permeability is slow in the subsoil of the Aberdeen soil and moderate to slow in the underlying material. It is very slow in the subsoil of the Nahon soil and moderately slow to very slow in the underlying material. Available water capacity is moderate or high in the Aberdeen soil and moderate in the Nahon soil. During wet periods the water table is at a depth of 4 to 6 feet in both soils. Runoff is slow. The shrink-swell potential is high in the subsoil of both soils. It is low in the underlying material of the Aberdeen soil and moderate in the underlying material of the Nahon soil.

Most areas are used as cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and crested wheatgrass. Wheat, corn, barley, sunflowers, soybeans, and oats are the main crops (fig. 7). The dense claypan subsoil in the Nahon soil and the sodium in both soils restrict crop growth by limiting root penetration and the rate of water intake. Measures that conserve moisture, increase the rate of water intake, and improve tilth are the main management needs. Examples are applying animal manure, leaving crop residue on the surface, and including grasses and legumes in the cropping sequence. Chiseling and subsoiling increase the rate of water intake and improve tilth.

If these soils are used for range, the dense claypan subsoil in the Nahon soil limits productivity and the variety of suitable grasses. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth.

These soils are suited to windbreaks and environmental plantings, but the dense claypan subsoil in the Nahon soil is a limitation. Trees and shrubs can be established on both soils, but optimum growth, survival, and vigor are unlikely.

These soils are suited to building site development, but the high shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. The varves in the underlying material result in slow absorption of liquid waste. Enlarging the absorption area helps to overcome the slow absorption rate.

The Aberdeen soil is in capability unit IIIs-1, Clayey range site, and windbreak suitability group 4L; the Nahon soil is in capability unit IVs-2, Claypan range site, and windbreak suitability group 9.

Ac—Aberdeen-Nahon silty clay loams, sandy substratum. These deep, level and nearly level soils are on outwash plains. The moderately well drained Aberdeen soil is on back slopes. The moderately well drained and somewhat poorly drained Nahon soil is on the lower back slopes and upper foot slopes. Areas are irregular in shape and range from 10 to more than 300 acres in size. They are 45 to 55 percent Aberdeen soil and 25 to 35 percent Nahon soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Aberdeen soil is dark gray silty clay loam about 8 inches thick. Below this is a mixed layer about 3 inches thick. This layer is gray silty clay loam that has gray silt coatings on faces of peds. The subsoil is about 27 inches thick. The upper part is dark gray, firm silty clay. The lower part is light gray and light brownish gray, firm, calcareous silty clay loam that has nests of gypsum and other salts. The upper part of the underlying material is light gray, calcareous silt loam. The lower part to a depth of 60 inches is light brownish gray fine sand.

Typically, the surface layer of the Nahon soil is dark gray silty clay loam about 6 inches thick. The subsurface layer is gray silt loam about 3 inches thick. The subsoil is about 28 inches thick. The upper part is gray, firm silty clay and grayish brown, firm silty clay

Figure 7.—Spring wheat in an area of Aberdeen-Nahon silty clay loams.

loam. The lower part is light brownish gray and pale yellow, firm and friable silty clay loam. It is calcareous and has nests of gypsum and other salts. The upper part of the underlying material is white and grayish brown, calcareous silty clay loam. The lower part to a depth of 60 inches is light brownish gray fine sand.

Included with these soils in mapping are small areas of Exline soils that have a sandy substratum and small areas of Harmony Variant soils. These included soils make up less than 15 percent of this map unit. Exline soils have visible crystals of salt within a depth of 16 inches. They are slightly lower on the landscape than the Nahon soil. Harmony Variant soils do not have a sodium-affected subsoil. They are slightly higher on the landscape than the Aberdeen soil.

The content of organic matter is moderate in the Aberdeen and Nahon soils, and fertility is medium. Both soils have a sodium-affected subsoil. Tilth is fair in the Aberdeen soil and poor in the Nahon soil. Permeability is slow in the subsoil of the Aberdeen soil and rapid in the sandy underlying material. It is very slow in the subsoil of the Nahon soil and rapid in the sandy underlying material. Available water capacity is moderate or high in the Aberdeen soil and moderate in the Nahon soil. The water table is at a depth of 3.5 to 6.0 feet during wet periods in both soils. Runoff is slow. The shrink-swell potential is high in the subsoil and low in the underlying material.

Most areas are used as cropland. These soils are suited to cultivated crops and to tame pasture and hay.

Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and crested wheatgrass. Wheat, corn, barley, and oats are the main crops. The dense claypan subsoil in the Nahon soil and the sodium in both soils restrict crop growth by limiting root penetration and the rate of water intake. Measures that conserve moisture, increase the rate of water intake, and improve tilth are the main management needs. Applying animal manure, leaving crop residue on the surface, and including grasses and legumes in the cropping sequence are examples. Chiseling and subsoiling increase the rate of water intake and improve tilth.

If these soils are used for range, the dense claypan subsoil in the Nahon soil limits productivity and the variety of suitable grasses. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth.

These soils are suited to windbreaks and environmental plantings, but the dense claypan subsoil in the Nahon soil is a limitation. Trees and shrubs can be established on both soils, but optimum growth, survival, and vigor are unlikely.

These soils are suited to building site development, but the high shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are generally unsuited to septic tank absorption fields because of the wetness and the restricted permeability.

The Aberdeen soil is in capability unit IIIs-1, Clayey range site, and windbreak suitability group 4L; the Nahon soil is in capability unit IVs-2, Claypan range site, and windbreak suitability group 9.

Ad—Aberdeen-Urban land complex. This map unit consists of a deep, level and nearly level, moderately well drained Aberdeen soil intermingled with areas of Urban land. The unit is on glacial lake plains. It is in built-up areas in the city of Aberdeen. Areas range from 100 to 2,500 acres in size and are irregular in shape. They are 45 to 55 percent Aberdeen soil and 25 to 40 percent Urban land. The Aberdeen soil and the Urban land occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Aberdeen soil is dark gray silty clay loam about 8 inches thick. Below this is a mixed layer about 3 inches thick. This layer is gray silty clay loam that has gray silt coatings on faces of peds. The subsoil is about 27 inches thick. The upper part is dark gray, firm silty clay. The lower part is light gray and light brownish gray, firm, calcareous silty clay loam that has nests of gypsum and other salts. The upper part of the underlying material is light gray, calcareous silt loam. The lower part to a depth of 60 inches is pale yellow, calcareous silt loam varved with silty clay and very fine sandy loam.

The Urban land is covered by streets, parking lots, buildings, sidewalks, driveways, patios, and other structures that so obscure or alter the soils that identification of the soil series is not feasible. Most of the structures are single-unit dwellings, but about 15 percent of them are multiple-unit dwellings, businesses, shopping centers, schools, and churches on sites that have paved parking lots. Because of the flat topography, much of the landscape has not been greatly disturbed during construction.

Included in mapping are small areas of Beotia, Dovray, Exline, Harmony, and Nahon soils. These soils make up 10 to 20 percent of this map unit. The well drained Beotia soils are on the slightly higher parts of the landscape. They contain less clay than the Aberdeen soil. The poorly drained and very poorly drained Dovray soils are on flood plains. Exline soils have visible crystals of salt within a depth of 16 inches. They are on foot slopes. Harmony soils do not have a sodium-affected subsoil. They are on the slightly higher parts of the landscape. Nahon soils have columnar structure in the subsoil. They are on the slightly lower parts of the landscape.

The content of organic matter is moderate in the Aberdeen soil, and fertility is medium. This soil has a sodium-affected subsoil. Tilth is fair. Permeability is slow in the subsoil and moderate to slow in the underlying material. Available water capacity is moderate or high. The water table is at a depth of 4 to 6 feet during wet periods. Runoff is slow. Most areas are artificially drained through sewer systems and gutters. The shrink-swell potential is high in the subsoil and low in the underlying material.

The Aberdeen soil is used for building site development, lawns, open areas, gardens, or parks. It is suited to grasses, flowers, vegetables, trees, and shrubs, but the dense claypan subsoil limits root development. The perennial plants selected for planting should be those that have a fairly high tolerance for drought and salts. Measures that conserve moisture, increase the rate of water intake, and improve tilth are the main management needs. The soil is suited to windbreaks and environmental plantings, but optimum growth, survival, and vigor are unlikely.

The Aberdeen soil is suited to building site development. Among the management concerns

affecting urban development are runoff, cracking and shifting of structures because of the shrink-swell potential, and failure of pipelines and steel because of corrosivity and salinity. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

The Aberdeen soil is suited to septic tank absorption fields, but the restricted permeability is a limitation. The varves in the underlying material result in slow absorption of liquid waste. Enlarging the absorption area helps to overcome the slow absorption rate. Where possible, sanitary facilities should be connected to commercial sewers and treatment facilities. Onsite investigation is essential to properly evaluate and plan the development of specific sites for buildings and sanitary facilities.

No capability unit, range site, or windbreak suitability group is assigned.

Ar—Arveson fine sandy loam. This deep, poorly drained and very poorly drained, level and nearly level soil is on glacial lake plains. Areas are oval or irregularly shaped and range from 5 to 100 acres in size. Slopes are smooth or slightly concave.

Typically, the surface layer is gray, calcareous fine sandy loam about 9 inches thick. The subsoil is gray and light gray, friable, calcareous fine sandy loam about 15 inches thick. The underlying material to a depth of 60 inches is light gray, calcareous loamy fine sand.

Included with this soil in mapping are small areas of Embden, Hecla, Stirum, Ulen, and Wyndmere soils. These soils make up less than 15 percent of this map unit. They are higher on the landscape than the Arveson soil. Embden soils are well drained or moderately well drained. Hecla soils contain more sand than the Arveson soil. Stirum soils have a sodium-affected subsoil. Ulen soils are moderately well drained or somewhat poorly drained. Wyndmere soils are somewhat poorly drained.

The content of organic matter is high in the Arveson soil, and fertility is medium. Permeability is moderate or moderately rapid in the subsoil and moderately rapid or rapid in the underlying material. Available water capacity is low. The water table is at a depth of 1 to 2 feet during wet periods. Runoff is slow.

Most of the acreage supports native grasses and is used for grazing. This soil is generally unsuited to cultivated crops, windbreaks and environmental plantings, building site development, and septic tank absorption fields because of the wetness. It is suited to tame pasture and hay, but the wetness is a limitation. Garrison creeping foxtail and reed canarygrass are suitable species.

This soil is in capability unit Vw-3, Subirrigated range site, and windbreak suitability group 10.

BaD—Barnes-Buse loams, 6 to 15 percent slopes. These deep, well drained, gently rolling and rolling soils are on moraines. The Barnes soil is on the middle and lower back slopes, and the Buse soil is on the upper back slopes and shoulder slopes. In places scattered stones are on the surface. Areas are irregularly shaped or elongated and range from 20 to 200 acres in size. They are 50 to 75 percent Barnes soil and 20 to 35 percent Buse soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is dark gray loam about 7 inches thick. The subsoil is about 33 inches thick. It is friable. It is brown clay loam and pale brown loam in the upper part and light brownish gray, calcareous loam in the lower part. The underlying material to a depth of 60 inches is light brownish gray, calcareous loam. In places the subsoil contains more clay.

Typically, the surface layer of the Buse soil is dark gray, calcareous loam about 7 inches thick. The subsoil is pale brown, friable, calcareous loam about 15 inches thick. The underlying material to a depth of 60 inches is light yellowish brown, calcareous loam.

Included with these soils in mapping are small areas of Egeland and Svea soils. These included soils make up less than 15 percent of this map unit. Egeland soils contain less clay and more sand than the Barnes soil. They are on foot slopes and in positions on the landscape similar to those of the Barnes soil. Svea soils are dark to a depth of more than 16 inches. They are on foot slopes.

The content of organic matter is moderate in the Barnes soil and low to moderate in the Buse soil. Fertility is medium in the Barnes soil and low or medium in the Buse soil. Permeability is moderate in the subsoil of the Barnes soil and moderately slow in the underlying material. It is moderately slow in the Buse soil. Available water capacity is high in both soils. Runoff is medium or rapid on the Barnes soil and rapid on the Buse soil. The shrink-swell potential is moderate in both soils.

Most of the acreage supports native grasses and is used for grazing. Water erosion is a hazard if the range is overgrazed. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity and control water erosion.

These soils are suited to cultivated crops and to tame pasture and hay. Alfalfa, intermediate wheatgrass,

and smooth brome are examples of suitable pasture grasses. Water erosion is a severe hazard. A high content of lime in the surface layer of the Buse soil restricts the availability of plant nutrients. Measures that control erosion and improve fertility are the main management needs. Minimizing tillage and leaving crop residue on the surface are examples. Including grasses and legumes in the cropping sequence helps to control erosion and improves fertility. Contour farming, grassed waterways, and terraces can help to control erosion, but in most areas the slopes are too short or too irregular for contouring and terracing. Grassed waterways help to keep gullies from forming.

The Barnes soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on this soil, except for those that require an abundant supply of moisture. No trees or shrubs grow well on the Buse soil.

These soils are suited to building site development, but the moderate shrink-swell potential and the slope are limitations. Buildings should be designed so that they conform to the natural slope of the land. In some areas land shaping is needed. Backfilling with sandy material and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are suited to septic tank absorption fields, but the restricted permeability and the slope are limitations. The absorption fields should be installed in the less sloping areas. Enlarging the absorption area helps to overcome a slow absorption rate. Land shaping and installing the distribution lines across the slope improve the efficiency of the absorption system.

The Barnes soil is in capability unit IVe-1, Silty range site, and windbreak suitability group 3; the Buse soil is in capability unit VIe-3, Thin Upland range site, and windbreak suitability group 8.

BbC—Barnes-Buse-Svea loams, 1 to 9 percent slopes. These deep, nearly level to gently rolling soils are on moraines dissected by many small drainageways. The well drained Barnes soil is on back slopes, the well drained Buse soil is on shoulder slopes, and the moderately well drained Svea soil is on foot slopes. Most areas are irregular in shape and range from 25 to 150 acres in size. They are 40 to 50 percent Barnes soil, 20 to 25 percent Buse soil, and 15 to 20 percent Svea soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is dark gray loam about 7 inches thick. The subsoil is about 33 inches thick. It is friable. It is brown clay loam and pale brown loam in the upper part and light brownish gray, calcareous loam in the lower part. The underlying material to a depth of 60 inches is light brownish gray, calcareous loam. In places the subsoil contains more clay.

Typically, the surface layer of the Buse soil is dark gray, calcareous loam about 7 inches thick. The subsoil is pale brown, friable, calcareous loam about 15 inches thick. The underlying material to a depth of 60 inches is light yellowish brown, calcareous loam.

Typically, the surface layer of the Svea soil is dark gray loam about 8 inches thick. The subsurface layer also is dark gray loam. It is about 7 inches thick. The subsoil is about 21 inches thick. It is friable. The upper part is grayish brown loam, and the lower part is pale yellow, calcareous clay loam. The underlying material to a depth of 60 inches is light yellowish brown, calcareous clay loam. In places the subsoil contains more clay.

Included with these soils in mapping are small areas of Cresbard and Tonka soils. These included soils make up less than 15 percent of this map unit. Cresbard soils have a sodium-affected subsoil. They are in positions on the landscape similar to those of the Svea soil. The poorly drained Tonka soils are in basins.

The content of organic matter is moderate in the Barnes soil, low to moderate in the Buse soil, and high in the Svea soil. Fertility is medium in the Barnes soil, low or medium in the Buse soil, and high in the Svea soil. Permeability is moderate in the subsoil of the Barnes and Svea soils and moderately slow in the underlying material. It is moderately slow in the Buse soil. Available water capacity is high in all three soils. The Svea soil has a water table at a depth of 4 to 6 feet during wet periods. Runoff is medium or rapid on the Barnes soil, rapid on the Buse soil, and slow on the Svea soil. The shrink-swell potential is moderate in all three soils.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Alfalfa, intermediate wheatgrass, and smooth brome are examples of suitable pasture plants. Wheat, corn, barley, and oats are the main crops. A high content of lime in the surface layer of the Buse soil limits productivity by restricting the availability of plant nutrients. Controlling erosion on all three soils and improving the fertility of the Buse soil are the main management needs. Minimizing tillage, leaving crop residue on the surface, and including grasses and legumes in the cropping sequence help to control erosion, conserve moisture, and improve fertility. Contour farming, grassed waterways, and terraces can help to control erosion, but in most areas the slopes are too short or too irregular for contouring and terracing.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Barnes soil, except for those that require an abundant supply of moisture. The Svea soil is especially well suited to the species that require an abundant supply of moisture. The high content of lime in the surface layer of the Buse soil is a limitation. Trees and shrubs can be established on this soil, but optimum survival, growth, and vigor are unlikely.

The Barnes and Buse soils are suited to building site development, but the moderate shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. Buildings should be designed so that they conform to the natural slope of the land. In some areas land shaping is needed.

The Barnes and Buse soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate. Land shaping and installing the distribution lines across the slope improve the efficiency of the absorption system.

The Svea soil is generally unsuitable as a site for buildings and septic tank absorption fields because it is subject to overland flow.

The Barnes soil is in capability unit IIIe-2, Silty range site, and windbreak suitability group 3; the Buse soil is in capability unit IVe-3, Thin Upland range site, and windbreak suitability group 8; the Svea soil is in capability unit IIc-3, Overflow range site, and windbreak suitability group 1.

BcA—Barnes-Cavour loams, 0 to 3 percent slopes. These deep, level to gently undulating soils are on till plains. The well drained Barnes soil is on back slopes, and the moderately well drained Cavour soil is on foot slopes. Areas are irregular in shape and range from 10 to 150 acres in size. They are 50 to 60 percent Barnes soil and 20 to 30 percent Cavour soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is dark gray loam about 7 inches thick. The subsoil is about 33 inches thick. It is friable. It is brown clay loam and pale brown loam in the upper part and light brownish gray, calcareous loam in the lower part. The underlying material to a depth of 60 inches is light brownish gray, calcareous loam.

Typically, the surface layer of the Cavour soil is dark gray loam about 8 inches thick. The subsurface layer is gray loam about 2 inches thick. The subsoil is about 17 inches thick. It is firm. The upper part is dark grayish brown clay. The lower part is grayish brown, calcareous clay loam that has nests of salt. The underlying material to a depth of 60 inches is light brownish gray and light gray, calcareous clay loam.

Included with these soils in mapping are small areas of Cresbard, Hamerly, Svea, and Tonka soils. These included soils make up less than 20 percent of this map unit. Cresbard and Svea soils are in positions on the landscape similar to those of the Cavour soil. Cresbard soils do not have columnar structure in the subsoil. Svea soils do not have a sodium-affected subsoil and are dark to a depth of more than 16 inches. Hamerly soils have free lime at the surface. They are on toe slopes. The poorly drained Tonka soils are in basins.

The content of organic matter is moderate in the Barnes and Cavour soils, and fertility is medium. The Cavour soil has a sodium-affected subsoil. Tilth is good in the Barnes soil and poor in the Cavour soil. Permeability is moderate in the subsoil of the Barnes soil and moderately slow in the underlying material. It is very slow or slow in the subsoil of the Cavour soil and moderately slow or slow in the underlying material. Available water capacity is high in the Barnes soil and moderate in the Cavour soil. Runoff is slow on both soils. The shrink-swell potential is moderate in the Barnes soil. It is high in the subsoil of the Cavour soil and moderate in the underlying material.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, smooth brome, and intermediate wheatgrass. Wheat, barley, corn, and oats are the main crops. The sodium-affected subsoil in the Cavour soil restricts crop growth by limiting root penetration and the rate of water intake. Measures that conserve moisture in the Barnes soil and increase the rate of water intake and improve tilth in the Cavour soil are the main management needs. Leaving crop residue on the surface, minimizing tillage, and including grasses and legumes in the cropping sequence are examples. Chiseling and subsoiling improve tilth and increase the rate of water intake.

If these soils are used for range, the dense, sodium-affected subsoil in the Cavour soil limits productivity and the variety of suitable grasses. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity. Surface compaction is a problem on the Cavour soil during wet periods.

Restricted grazing during these periods helps to prevent compaction and deterioration of tilth.

These soils are suited to windbreaks and environmental plantings, but the dense claypan subsoil in the Cavour soil is a limitation. All climatically suited trees and shrubs grow well on the Barnes soil, except for those that require an abundant supply of moisture. The sodium-affected subsoil in the Cavour soil severely limits root penetration. Optimum growth, survival, and vigor are unlikely on this soil.

These soils are suited to building site development, but the moderate shrink-swell potential in the Barnes soil and the high shrink-swell potential in the Cavour soil are limitations. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Barnes soil is in capability unit IIc-2, Silty range site, and windbreak suitability group 3; the Cavour soil is in capability unit IVs-2, Claypan range site, and windbreak suitability group 9.

BcB—Barnes-Cavour loams, 3 to 6 percent slopes. These deep, gently undulating and undulating soils are on till plains. The well drained Barnes soil is on back slopes, and the moderately well drained Cavour soil is on foot slopes. Areas are irregular in shape and range from 10 to 150 acres in size. They are 50 to 60 percent Barnes soil and 20 to 30 percent Cavour soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is dark gray loam about 7 inches thick. The subsoil is about 33 inches thick. It is friable. It is brown clay loam and pale brown loam in the upper part and light brownish gray, calcareous loam in the lower part. The underlying material to a depth of 60 inches is light brownish gray, calcareous loam.

Typically, the surface layer of the Cavour soil is dark gray loam about 8 inches thick. The subsurface layer is gray loam about 2 inches thick. The subsoil is about 17 inches thick. It is firm. The upper part is dark grayish brown clay. The lower part is grayish brown, calcareous clay loam that has nests of salt. The underlying material to a depth of 60 inches is light brownish gray and light gray, calcareous clay loam.

Included with these soils in mapping are small areas of Buse, Cresbard, Hamerly, Svea, and Tonka soils. These included soils make up less than 20 percent of this map unit. Buse soils have lime at or near the surface. They are on shoulder slopes. Cresbard and Svea soils are in positions on the landscape similar to those of the Cavour soil. Cresbard soils do not have columnar structure in the subsoil. Svea soils do not have a sodium-affected subsoil and are dark to a depth of more than 16 inches. Hamerly soils have lime at the surface. They are on toe slopes. The poorly drained Tonka soils are in basins.

The content of organic matter is moderate in the Barnes and Cavour soils, and fertility is medium. The Cavour soil has a sodium-affected subsoil. Tilth is good in the Barnes soil and poor in the Cavour soil. Permeability is moderate in the subsoil of the Barnes soil and moderately slow in the underlying material. It is very slow or slow in the subsoil of the Cavour soil and moderately slow or slow in the underlying material. Available water capacity is high in the Barnes soil and moderate in the Cavour soil. Runoff is medium on the Barnes soil and slow on the Cavour soil. The shrink-swell potential is moderate in the Barnes soil. It is high in the subsoil of the Cavour soil and moderate in the underlying material.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, smooth brome, and intermediate wheatgrass. Wheat, barley, corn, and oats are the main crops. The sodium-affected subsoil in the Cavour soil restricts crop growth by limiting root penetration and the rate of water intake. Controlling erosion and conserving moisture in areas of the Barnes soil and increasing the rate of water intake and improving tilth in the Cavour soil are the main management needs. Leaving crop residue on the surface and minimizing tillage help to control erosion and conserve moisture. Contour farming, grassed waterways, and terraces can help to control erosion, but most slopes are too short or too irregular for contouring and terracing. A cropping sequence that includes grasses and legumes, timely tillage, and chiseling or subsoiling increase the rate of water intake and improve tilth.

If these soils are used for range, the dense, sodium-affected subsoil in the Cavour soil limits productivity and the variety of suitable grasses. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity. Surface compaction is a problem on the Cavour soil during wet periods. Restricted grazing during these periods helps to prevent compaction and deterioration of tilth.

These soils are suited to windbreaks and environmental plantings, but the dense claypan subsoil in the Cavour soil is a limitation. All climatically suited

trees and shrubs grow well on the Barnes soil, except for those that require an abundant supply of moisture. The sodium-affected subsoil severely limits root penetration in the Cavour soil. Optimum growth, survival, and vigor are unlikely on this soil.

These soils are suited to building site development, but the moderate shrink-swell potential in the Barnes soil and the high shrink-swell potential in the Cavour soil are limitations. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Barnes soil is in capability unit IIe-2, Silty range site, and windbreak suitability group 3; the Cavour soil is in capability unit IVs-3, Claypan range site, and windbreak suitability group 9.

BdA—Barnes-Cresbard-Tonka complex, 0 to 3 percent slopes. These deep, level to gently undulating soils are on till plains. The well drained Barnes soil is on back slopes, the moderately well drained Cresbard soil is on foot slopes, and the poorly drained Tonka soil is in basins. The Tonka soil is ponded during spring runoff and after heavy rains. Areas are irregular in shape and range from 20 to more than 1,000 acres in size. They are 45 to 55 percent Barnes soil, 20 to 25 percent Cresbard soil, and 10 to 15 percent Tonka soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is dark gray loam about 7 inches thick. The subsoil is about 33 inches thick. It is friable. It is brown clay loam and pale brown loam in the upper part and light brownish gray, calcareous loam in the lower part. The underlying material to a depth of 60 inches is light brownish gray, calcareous loam. In places the subsoil contains more clay.

Typically, the surface layer of the Cresbard soil is dark gray silt loam about 7 inches thick. The subsurface layer is grayish brown silt loam about 3 inches thick. Below this is a transitional layer about 6 inches thick. This layer is grayish brown silty clay loam that has gray silt coatings on faces of peds. The subsoil is about 29 inches thick. It is firm. It is grayish brown and light brownish gray silty clay in the upper part and light yellowish brown, calcareous clay loam in the lower part. The underlying material to a depth of 60 inches is light yellowish brown, calcareous clay loam. In places the subsoil contains less clay.

Typically, the surface layer of the Tonka soil is gray silt loam about 9 inches thick. The subsurface layer is light gray silt loam about 9 inches thick. The subsoil is about 32 inches thick. It is firm. It is gray silty clay in the upper part and light brownish gray and light gray silty clay loam in the lower part. The underlying material to a depth of 60 inches is light gray silty clay loam.

Included with these soils in mapping are small areas of Cavour, Hamerly, Nishon, and Svea soils. These included soils make up less than 15 percent of this map unit. Cavour soils have columnar structure in the subsoil. They are in positions on the landscape similar to those of the Cresbard soil. Hamerly soils have free lime at the surface. They are on toe slopes. Nishon soils have a surface layer that is thinner than that of the Tonka soil. They are in positions on the landscape similar to those of the Tonka soil. Svea soils have a surface layer that is thicker than that of the Barnes soil. They are in positions on the landscape similar to those of the Cresbard soil.

The content of organic matter is moderate in the Barnes and Cresbard soils and high in the Tonka soil. Fertility is medium in the Barnes and Cresbard soils and high in the Tonka soil. The Cresbard soil has a sodium-affected subsoil. Tilth is good in the Barnes soil and fair in the Cresbard and Tonka soils. Permeability is moderate in the subsoil of the Barnes soil and moderately slow in the underlying material. It is moderately slow or slow in the Cresbard soil and slow in the Tonka soil. Available water capacity is high in the Barnes and Tonka soils and moderate in the Cresbard soil. The Tonka soil has a water table within a depth of 1 foot during wet periods. As much as 0.5 foot of water may pond on this soil. Runoff is slow on the Barnes and Cresbard soils and ponded on the Tonka soil. The shrink-swell potential is moderate in the Barnes soil and high in the Tonka soil. It is high in the subsoil of the Cresbard soil and moderate in the underlying material.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Water-tolerant species, such as Garrison creeping foxtail and reed canarygrass, also are suitable on the Tonka soil. Wheat, corn, barley, and sunflowers are the main crops. The sodium-affected subsoil in the Cresbard soil restricts root penetration. Conserving moisture in the Barnes and Cresbard soils and controlling ponding on the Tonka soil are the main management concerns. Leaving crop residue on the surface, minimizing tillage, and including grasses and legumes in the cropping sequence conserve moisture. In most years planting is

delayed on the Tonka soil because of ponding. Suitable drainage outlets generally are not available.

No major hazards or limitations affect the use of the Barnes and Cresbard soils for range. Surface compaction is a problem on the Tonka soil during wet periods. Restricted grazing during these periods helps to prevent compaction. Many areas of the Tonka soil are potential sites for excavated ponds.

The Barnes soil is suited to windbreaks and environmental plantings. Except for the species that require an abundant supply of moisture, all climatically suited trees and shrubs grow well on this soil. The Cresbard soil is suited to windbreaks and environmental plantings. It takes in water slowly, however, and the clayey subsoil restricts the penetration of plant roots. Windbreaks can be established on this soil, but optimum growth is unlikely. The Tonka soil is generally unsuited to windbreaks and environmental plantings unless it is drained.

The Barnes and Cresbard soils are suited to building site development, but the moderate shrink-swell potential in the Barnes soil and the high shrink-swell potential in the subsoil of the Cresbard soil are limitations. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

The Barnes and Cresbard soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Tonka soil is generally unsuitable as a site for buildings and sanitary facilities because of the ponding.

The Barnes soil is in capability unit IIc-2, Silty range site, and windbreak suitability group 3; the Cresbard soil is in capability unit IIIs-1, Clayey range site, and windbreak suitability group 4L; the Tonka soil is in capability unit IVw-1, Wet Meadow range site, and windbreak suitability group 10.

BdB—Barnes-Cresbard-Tonka complex, 0 to 6 percent slopes. These deep, level to undulating soils are on till plains. The well drained Barnes soil is on back slopes, the moderately well drained Cresbard soil is on foot slopes, and the poorly drained Tonka soil is in basins. The Tonka soil is ponded during spring runoff and after heavy rains. Areas are irregular in shape and range from 20 to more than 1,000 acres in size. They are 40 to 50 percent Barnes soil, 20 to 25 percent Cresbard soil, and 10 to 15 percent Tonka soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is dark gray loam about 7 inches thick. The subsoil is about 33 inches thick. It is friable. It is brown clay loam and pale brown loam in the upper part and light brownish gray, calcareous loam in the lower part. The underlying material to a depth of 60 inches is light brownish gray, calcareous loam. In places the subsoil contains more clay.

Typically, the surface layer of the Cresbard soil is dark gray silt loam about 7 inches thick. The subsurface layer is grayish brown silt loam about 3 inches thick. Below this is a transitional layer about 6 inches thick. This layer is grayish brown silty clay loam that has gray silt coatings on faces of peds. The subsoil is about 29 inches thick. It is firm. It is grayish brown and light brownish gray silty clay in the upper part and light yellowish brown, calcareous clay loam in the lower part. The underlying material to a depth of 60 inches is light yellowish brown, calcareous clay loam. In places the subsoil contains less clay.

Typically, the surface layer of the Tonka soil is gray silt loam about 9 inches thick. The subsurface layer is light gray silt loam about 9 inches thick. The subsoil is about 32 inches thick. It is firm. It is gray silty clay in the upper part and light brownish gray and light gray silty clay loam in the lower part. The underlying material to a depth of 60 inches is light gray silty clay loam.

Included with these soils in mapping are small areas of Buse, Cavour, Hamerly, Nishon, and Svea soils. These included soils make up less than 20 percent of this map unit. Buse soils have lime at or near the surface. They are on shoulder slopes. Cavour soils have columnar structure in the subsoil. They are in positions on the landscape similar to those of the Cresbard soil. Hamerly soils have free lime at the surface. They are on toe slopes. Nishon soils have a surface layer that is thinner than that of the Tonka soil. They are in positions on the landscape similar to those of the Tonka soil. Svea soils have a surface layer that is thicker than that of the Barnes soil. They are in positions on the landscape similar to those of the Cresbard soil.

The content of organic matter is moderate in the Barnes and Cresbard soils and high in the Tonka soil. Fertility is medium in the Barnes and Cresbard soils and high in the Tonka soil. The Cresbard soil has a sodium-affected subsoil. Tilth is good in the Barnes soil and fair in the Cresbard and Tonka soils. Permeability is moderate in the subsoil of the Barnes soil and moderately slow in the underlying material. It is moderately slow or slow in the Cresbard soil and slow in the Tonka soil. Available water capacity is high in the Barnes and Tonka soils and moderate in the Cresbard soil. The Tonka soil has a water table within a depth of

1 foot during wet periods. As much as 0.5 foot of water may pond on this soil. Runoff is medium on the Barnes soil, slow on the Cresbard soil, and ponded on the Tonka soil. The shrink-swell potential is moderate in the Barnes soil and high in the Tonka soil. It is high in the subsoil of the Cresbard soil and moderate in the underlying material.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Water-tolerant species, such as Garrison creeping foxtail and reed canarygrass, also are suitable on the Tonka soil. Wheat, barley, corn, and sunflowers are the main crops. The sodium-affected subsoil in the Cresbard soil restricts root penetration. Controlling erosion and conserving moisture in areas of the Barnes and Cresbard soils and controlling ponding on the Tonka soil are the main management concerns. Leaving crop residue on the surface, minimizing tillage, and including grasses and legumes in the cropping sequence help to control erosion and conserve moisture. In most years planting is delayed on the Tonka soil because of ponding. Suitable drainage outlets generally are not available. In most areas the slopes are too short and too irregular for contouring and terracing. Grassed waterways help to keep gullies from forming.

No major hazards or limitations affect the use of the Barnes and Cresbard soils for range. Surface compaction is a problem on the Tonka soil during wet periods. Restricted grazing during these periods helps to prevent compaction. Many areas of the Tonka soil are potential sites for excavated ponds.

The Barnes soil is suited to windbreaks and environmental plantings. Except for the species that require an abundant supply of moisture, all climatically suited trees and shrubs grow well on this soil. The Cresbard soil is suited to windbreaks and environmental plantings, but the clayey subsoil restricts the penetration of plant roots. Windbreaks can be established on this soil, but optimum growth is unlikely. The Tonka soil is generally unsuited to windbreaks and environmental plantings unless it is drained.

The Barnes and Cresbard soils are suited to building site development, but the moderate shrink-swell potential in the Barnes soil and the high shrink-swell potential in the subsoil of the Cresbard soil are limitations. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

The Barnes and Cresbard soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Tonka soil is generally unsuitable as a site for buildings and sanitary facilities because of the ponding.

The Barnes soil is in capability unit IIe-2, Silty range site, and windbreak suitability group 3; the Cresbard soil is in capability unit IIIe-15, Clayey range site, and windbreak suitability group 4L; the Tonka soil is in capability unit IVw-1, Wet Meadow range site, and windbreak suitability group 10.

BeA—Barnes-Ferney-Tonka complex, 0 to 4 percent slopes. These deep, level to undulating soils are on till plains. The well drained Barnes soil is on back slopes, the moderately well drained Ferney soil is on foot slopes, and the poorly drained Tonka soil is in basins. The Tonka soil is ponded during spring runoff and after heavy rains. Areas are irregular in shape and range from 20 to 1,000 acres in size. They are 40 to 50 percent Barnes soil, 20 to 25 percent Ferney soil, and 10 to 15 percent Tonka soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is dark gray loam about 7 inches thick. The subsoil is about 33 inches thick. It is friable. It is brown clay loam and pale brown loam in the upper part and light brownish gray, calcareous loam in the lower part. The underlying material to a depth of 60 inches is light brownish gray, calcareous loam.

Typically, the surface layer of the Ferney soil is dark gray clay loam about 5 inches thick. The subsoil is clay loam about 45 inches thick. The upper part is very dark grayish brown and very firm. The lower part is grayish brown and light yellowish brown, firm, and calcareous. It has nests of salt. The underlying material to a depth of 60 inches is light yellowish brown, calcareous clay loam.

Typically, the surface layer of the Tonka soil is gray silt loam about 9 inches thick. The subsurface layer is light gray silt loam about 9 inches thick. The subsoil is about 32 inches thick. It is firm. It is gray silty clay in the upper part and light brownish gray and light gray silty clay loam in the lower part. The underlying material to a depth of 60 inches is light gray silty clay loam.

Included with these soils in mapping are small areas of Buse, Cavour, Cresbard, Hamerly, Nishon, and Svea soils. These included soils make up less than 20 percent of this map unit. Buse soils have lime at or near the surface. They are on shoulder slopes. Cavour and Cresbard soils have salts below a depth of 16 inches. They are slightly higher on the landscape than the Ferney soil. The somewhat poorly drained Hamerly soils are on toe slopes. They have lime at the surface.

Nishon soils have a surface layer that is thinner than that of the Tonka soil. They are in positions on the landscape similar to those of the Tonka soil. Svea soils are dark to a depth of more than 16 inches. They are slightly higher on the landscape than the Ferney soil. Also included are saline spots less than 3 acres in size.

The content of organic matter is moderate in the Barnes and Ferney soils and high in the Tonka soil. Fertility is medium in the Barnes soil, low or medium in the Ferney soil, and high in the Tonka soil. The Ferney soil has a sodium-affected subsoil. Tilth is good in the Barnes soil, poor in the Ferney soil, and fair in the Tonka soil. Permeability is moderate in the subsoil of the Barnes soil and moderately slow in the underlying material. It is very slow in the Ferney soil and slow in the Tonka soil. Available water capacity is high in the Barnes and Tonka soils and moderate in the Ferney soil. The Tonka soil has a water table within a depth of 1 foot during wet periods. As much as 0.5 foot of water may pond on this soil. Runoff is medium on the Barnes soil, slow on the Ferney soil, and ponded on the Tonka soil. The shrink-swell potential is moderate in the Barnes soil and high in the Ferney and Tonka soils.

About half of the acreage supports native grasses and is used for grazing. If these soils are used for range, the sodium-affected subsoil in the Ferney soil limits productivity and the variety of suitable grasses. Surface compaction is a problem on the Ferney and Tonka soils during wet periods. Restricted grazing during these periods helps to prevent compaction and deterioration of tilth. Areas of the Tonka soil are potential sites for excavated ponds.

These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Garrison creeping foxtail and reed canarygrass also are suitable on the Tonka soil. Wheat, barley, corn, and oats are the main crops. No crops or grasses grow well on the Ferney soil. The sodium-affected subsoil in the Ferney soil and wetness in the Tonka soil severely limit productivity. The dense claypan subsoil and high content of sodium restrict crop growth by limiting root penetration and the rate of water intake. Tilling is difficult because the dense subsoil is near the surface. If the soils are cultivated when wet, they become cloddy. The main management needs are controlling erosion and conserving moisture in areas of the Barnes soil; conserving moisture, increasing the rate of water intake, and improving tilth in the Ferney soil; and controlling ponding on the Tonka soil. Leaving crop residue on the surface and minimizing tillage help to control erosion and conserve moisture. A cropping sequence that includes grasses and legumes, timely tillage, and chiseling or subsoiling increase the rate of water intake and improve tilth. In most years planting is delayed on the Tonka soil because of ponding. Surface drains help to remove the excess water. In most areas the slopes are too short or too irregular for contouring and terracing.

The Barnes soil is suited to windbreaks and environmental plantings, but the Ferney and Tonka soils are generally unsuited. The sodium-affected subsoil is the main limitation in the Ferney soil. The Tonka soil is generally unsuited to trees and shrubs unless it is drained. Except for the species that require an abundant supply of moisture, all climatically suited trees and shrubs grow well on the Barnes soil. No trees or shrubs grow well on the Ferney and Tonka soils.

The Barnes and Ferney soils are suited to building site development, but the moderate shrink-swell potential in the Barnes soil and the high shrink-swell potential in the Ferney soil are limitations. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

The Barnes and Ferney soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Tonka soil is generally unsuitable as a site for buildings and sanitary facilities because of the ponding.

The Barnes soil is in capability unit IIe-2, Silty range site, and windbreak suitability group 3; the Ferney soil is in capability unit VIs-1, Thin Claypan range site, and windbreak suitability group 10; the Tonka soil is in capability unit IVw-1, Wet Meadow range site, and windbreak suitability group 10.

BfA—Barnes-Hamerly-Tonka complex. These deep, level and nearly level soils are on till plains. The well drained Barnes soil is on the upper and middle back slopes, the somewhat poorly drained and moderately well drained Hamerly soil is on toe slopes, and the poorly drained Tonka soil is in basins. The Tonka soil is ponded during spring runoff and after heavy rains. Areas are irregular in shape and range from 10 to 200 acres in size. They are 45 to 55 percent Barnes soil, 20 to 30 percent Hamerly soil, and 10 to 15 percent Tonka soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is dark gray loam about 7 inches thick. The subsoil is about 33 inches thick. It is friable. It is brown clay loam and pale brown loam in the upper part and light brownish gray, calcareous loam in the lower part. The underlying

material to a depth of 60 inches is light brownish gray, calcareous loam.

Typically, the surface layer of the Hamerly soil is dark gray, calcareous loam about 7 inches thick. The subsoil is about 17 inches thick. It is friable and calcareous. It is light gray loam in the upper part and light brownish gray clay loam in the lower part. The underlying material to a depth of 60 inches is light yellowish brown, calcareous clay loam.

Typically, the surface layer of the Tonka soil is gray silt loam about 9 inches thick. The subsurface layer is light gray silt loam about 9 inches thick. The subsoil is about 32 inches thick. It is firm. It is gray silty clay in the upper part and light brownish gray and light gray silty clay loam in the lower part. The underlying material to a depth of 60 inches is light gray silty clay loam.

Included with these soils in mapping are small areas of Buse, Svea, and Vallers soils. These included soils make up less than 15 percent of this map unit. Buse and Vallers soils have lime at the surface. The well drained Buse soils are on shoulder slopes. The poorly drained Vallers soils are slightly lower on the landscape than the Hamerly soil. The moderately well drained Svea soils are on the upper foot slopes. They are dark to a depth of more than 16 inches. Also included are saline spots as much as 3 acres in size.

The content of organic matter is moderate in the Barnes soil and high in the Hamerly and Tonka soils. Fertility is medium in the Barnes and Hamerly soils and high in the Tonka soil. Permeability is moderate in the subsoil of the Barnes and Hamerly soils and moderately slow in the underlying material. It is slow in the Tonka soil. Available water capacity is high in all three soils. During wet periods, the Hamerly soil has a water table at a depth of 2 to 4 feet and the Tonka soil has one within a depth of 1 foot. As much as 0.5 foot of water may pond on the Tonka soil. Runoff is slow on the Barnes and Hamerly soils and ponded on the Tonka soil. The shrink-swell potential is moderate in the Barnes and Hamerly soils and high in the Tonka soil.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants on the Barnes and Hamerly soils are alfalfa, intermediate wheatgrass, and smooth brome. The choice of pasture plants is limited to water-tolerant species, such as Garrison creeping foxtail and reed canarygrass, on the Tonka soil. Wheat, corn, barley, and oats are the main crops. A high content of lime in the surface layer of the Hamerly soil and ponding on the Tonka soil are limitations. Conserving moisture in the Barnes soil, controlling wind erosion and improving fertility in areas of the Hamerly soil, and controlling ponding on the Tonka soil are the main management concerns. Tillage practices that leave crop residue on the surface conserve moisture, help to control erosion, and maintain fertility. In most years planting is delayed on the Tonka soil because of the ponding. Surface drains help to remove the excess water.

No major hazards or limitations affect the use of the Barnes and Hamerly soils for range. Surface compaction is a problem on the Tonka soil during wet periods. Restricted grazing during these periods helps to prevent compaction. Many areas of the Tonka soil are potential sites for excavated ponds.

The Barnes and Hamerly soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well. Those that require an abundant supply of moisture grow especially well on the Hamerly soil. The Tonka soil is generally unsuited to windbreaks and environmental plantings because of the ponding.

The Barnes soil is suited to building site development, but the moderate shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. The Barnes soil is suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Hamerly and Tonka soils are generally unsuited to most kinds of building site development and septic tank absorption fields because of the wetness in the Hamerly soil and the ponding on the Tonka soil. The Barnes soil is a better site for buildings and septic tank absorption fields.

The Barnes soil is in capability unit IIc-2, Silty range site, and windbreak suitability group 3; the Hamerly soil is in capability unit IIe-4, Limy Subirrigated range site, and windbreak suitability group 1; the Tonka soil is in capability unit IVw-1, Wet Meadow range site, and windbreak suitability group 10.

BgC—Barnes-Kranzburg-Buse complex, 5 to 9 percent slopes. These deep, well drained, undulating and gently rolling soils are on moraines. The Barnes soil is on the upper back slopes, the Kranzburg soil is on the middle and lower back slopes, and the Buse soil is on shoulder slopes. Areas are irregular in shape and range from 5 to 80 acres in size. They are 30 to 40 percent Barnes soil, 25 to 35 percent Kranzburg soil, and 20 to 30 percent Buse soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is dark

gray loam about 7 inches thick. The subsoil is about 33 inches thick. It is friable. It is brown clay loam and pale brown loam in the upper part and light brownish gray, calcareous loam in the lower part. The underlying material to a depth of 60 inches is light brownish gray, calcareous loam. In places the subsoil contains more clay.

Typically, the surface layer of the Kranzburg soil is dark gray silt loam about 7 inches thick. The subsoil is about 29 inches thick. The upper part is dark grayish brown and brown, friable silt loam. The lower part is light brownish gray, firm, calcareous clay loam. The underlying material to a depth of 60 inches is pale yellow and light gray, calcareous clay loam.

Typically, the surface layer of the Buse soil is dark gray, calcareous loam about 7 inches thick. The subsoil is pale brown, friable, calcareous loam about 15 inches thick. The underlying material to a depth of 60 inches is light yellowish brown, calcareous loam.

Included with these soils in mapping are small areas of Aastad and Brookings soils. These included soils make up less than 15 percent of this map unit. The moderately well drained Aastad and Brookings soils are on foot slopes and are dark to a depth of more than 16 inches.

The content of organic matter is moderate in the Barnes and Kranzburg soils and moderate to low in the Buse soil. Fertility is medium in the Barnes and Kranzburg soils and medium or low in the Buse soil. Permeability is moderate in the subsoil of the Barnes and Kranzburg soils and moderately slow in the underlying material. It is moderately slow in the Buse soil. Available water capacity is high. Runoff is medium or rapid on the Barnes and Kranzburg soils and rapid on the Buse soil. The shrink-swell potential is moderate in all three soils.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, barley, corn, and oats are the main crops. A high content of lime in the surface layer of the Buse soil limits productivity. Measures that control erosion and improve the fertility of the Buse soil are the main management needs. Leaving crop residue on the surface, minimizing tillage, and including grasses and legumes in the cropping sequence are examples. Terraces, contour farming, and grassed waterways help to control erosion.

No major hazards or limitations affect the use of these soils for range. Water erosion is a hazard, however, if the range is overgrazed. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity and control erosion.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Barnes and Kranzburg soils, except for those that require an abundant supply of moisture. The high content of lime in the Buse soil is a limitation. Trees and shrubs can be established on this soil, but optimum survival, growth, and vigor are unlikely.

These soils are suited to building site development, but the moderate shrink-swell potential and the slope are limitations. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. Buildings should be designed so that they conform to the natural slope of the land. In some areas land shaping is needed.

These soils generally are too steep for septic tank absorption fields. Also, the restricted permeability is a limitation. The absorption fields should be installed in the less sloping areas. Enlarging the absorption area helps to overcome a slow absorption rate. Land shaping and installing the distribution lines across the slope improve the efficiency of the absorption system.

The Barnes soil is in capability unit IIIe-2, Silty range site, and windbreak suitability group 3; the Kranzburg soil is in capability unit IIIe-1, Silty range site, and windbreak suitability group 3; the Buse soil is in capability unit IVe-3, Thin Upland range site, and windbreak suitability group 8.

BhA—Barnes-Svea loams, 0 to 3 percent slopes. These deep, level to gently undulating soils are on till plains. The well drained Barnes soil is on back slopes, and the moderately well drained Svea soil is on foot slopes. Areas are irregular in shape and range from 60 to more than 1,000 acres in size. They are 55 to 70 percent Barnes soil and 20 to 35 percent Svea soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is dark gray loam about 7 inches thick. The subsoil is about 33 inches thick. It is friable. It is brown clay loam and pale brown loam in the upper part and light brownish gray, calcareous loam in the lower part. The underlying material to a depth of 60 inches is light brownish gray, calcareous loam. In places the subsoil contains more clay.

Typically, the surface layer of the Svea soil is dark gray loam about 8 inches thick. The subsurface layer

also is dark gray loam. It is about 7 inches thick. The subsoil is about 21 inches thick. It is friable. The upper part is grayish brown loam, and the lower part is pale yellow, calcareous clay loam. The underlying material to a depth of 60 inches is light yellowish brown, calcareous clay loam. In some places the subsoil contains more clay. In other places the surface layer and subsoil are thicker.

Included with these soils in mapping are small areas of Cresbard, Hamerly, and Tonka soils. These included soils make up less than 15 percent of this map unit. Cresbard soils have a sodium-affected subsoil. They are in positions on the landscape similar to those of the Svea soil. The moderately well drained and somewhat poorly drained Hamerly soils are on toe slopes. They have free lime at the surface. The poorly drained Tonka soils are in basins.

The content of organic matter is moderate in the Barnes soil and high in the Svea soil. Fertility is medium in the Barnes soil and high in the Svea soil. Permeability is moderate in the subsoil of both soils and moderately slow in the underlying material. Available water capacity is high. The Svea soil has a water table at a depth of 4 to 6 feet during wet periods. Runoff is slow on both soils. The shrink-swell potential is moderate in both soils.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, barley, and sunflowers are the main crops. Measures that conserve moisture are the main management needs in areas of the Barnes soil. Leaving crop residue on the surface and minimizing tillage are examples. Because of runoff from the adjacent soils, planting and harvesting may be delayed on the Svea soil during wet periods. The additional moisture is beneficial, however, in most years.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Barnes soil, except for those that require an abundant supply of moisture. The Svea soil is especially well suited to the species that require an abundant supply of moisture.

The Barnes soil is suited to building site development, but the moderate shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. The Barnes soil is suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Svea soil is generally unsuited to building site development and septic tank absorption fields because it is subject to overland flow.

The Barnes soil is in capability unit IIc-2, Silty range site, and windbreak suitability group 3; the Svea soil is in capability unit IIc-3, Overflow range site, and windbreak suitability group 1.

BhB—Barnes-Svea loams, 1 to 6 percent slopes. These deep, nearly level and undulating soils are on till plains. The well drained Barnes soil is on back slopes, and the moderately well drained Svea soil is on foot slopes. Areas are irregular in shape and range from 10 to 300 acres in size. They are 55 to 70 percent Barnes soil and 20 to 35 percent Svea soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is dark gray loam about 7 inches thick. The subsoil is about 33 inches thick. It is friable. It is brown clay loam and pale brown loam in the upper part and light brownish gray, calcareous loam in the lower part. The underlying material to a depth of 60 inches is light brownish gray, calcareous loam. In places the subsoil contains more clay.

Typically, the Svea soil has a surface layer of dark gray loam about 8 inches thick. The subsurface layer also is dark gray loam. It is about 7 inches thick. The subsoil is about 21 inches thick. It is friable. The upper part is grayish brown loam, and the lower part is pale yellow, calcareous clay loam. The underlying material to a depth of 60 inches is light yellowish brown, calcareous clay loam. In places the subsoil contains more clay.

Included with these soils in mapping are small areas of Buse, Cresbard, Hamerly, Tally, and Tonka soils. These included soils make up less than 15 percent of this map unit. The well drained Buse soils are on shoulder slopes. They have lime at or near the surface. Cresbard soils have a sodium-affected subsoil. They are in positions on the landscape similar to those of the Svea soil. The moderately well drained and somewhat poorly drained Hamerly soils are on toe slopes. They have lime at the surface. Tally soils contain less clay and more sand in the subsoil than the Barnes and Svea soils. They are on shoulder slopes. The poorly drained Tonka soils are in basins.

The content of organic matter is moderate in the Barnes soil and high in the Svea soil. Fertility is medium in the Barnes soil and high in the Svea soil. Permeability is moderate in the subsoil of both soils and moderately slow in the underlying material. Available water capacity is high. The Svea soil has a water table at a depth of 4 to 6 feet during wet periods. Runoff is medium on the Barnes soil and slow on the Svea soil. The shrink-swell potential is moderate in both soils.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Alfalfa, intermediate wheatgrass, and smooth brome are suitable pasture plants. Wheat, corn, barley, and sunflowers are the main crops. Controlling erosion and conserving moisture in the Barnes soil are the main management needs. Tillage practices that leave crop residue on the surface help to control erosion and conserve moisture. Contour farming and terraces can help to control erosion, but in most areas the slopes are too short and irregular for contouring and terracing. Grassed waterways help to keep gullies from forming. Because of runoff from the adjacent soils, planting and harvesting may be delayed on the Svea soil during wet periods. The additional moisture is beneficial, however, in most years.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Barnes soil, except for those that require an abundant supply of moisture. The Svea soil is especially well suited to the species that require an abundant supply of moisture.

The Barnes soil is suited to building site development, but the moderate shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. The Barnes soil is suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Svea soil is generally unsuited to building site development and septic tank absorption fields because it is subject to overland flow.

The Barnes soil is in capability unit IIe-2, Silty range site, and windbreak suitability group 3; the Svea soil is in capability unit IIc-3, Overflow range site, and windbreak suitability group 1.

BkA—Barnes-Svea-Tonka complex, 0 to 3 percent slopes. These deep, level to gently undulating soils are on till plains. The well drained Barnes soil is on back slopes, the moderately well drained Svea soil is on foot slopes, and the poorly drained Tonka soil is in basins. The Tonka soil is ponded during spring runoff and after heavy rains. Areas are irregular in shape and range from 40 to more than 1,000 acres in size. They are 35 to 45 percent Barnes soil, 20 to 30 percent Svea soil, and 10 to 15 percent Tonka soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is dark gray loam about 7 inches thick. The subsoil is about 33 inches thick. It is friable. It is brown clay loam and pale brown loam in the upper part and light brownish gray, calcareous loam in the lower part. The underlying material to a depth of 60 inches is light brownish gray, calcareous loam. In places the subsoil contains more clay.

Typically, the surface layer of the Svea soil is dark gray loam about 8 inches thick. The subsurface layer also is dark gray loam. It is about 7 inches thick. The subsoil is about 21 inches thick. It is friable. The upper part is grayish brown loam, and the lower part is pale yellow, calcareous clay loam. The underlying material to a depth of 60 inches is light yellowish brown, calcareous clay loam. In some places the subsoil contains more clay. In other places the surface layer and subsoil are thicker.

Typically, the surface layer of the Tonka soil is gray silt loam about 9 inches thick. The subsurface layer is light gray silt loam about 9 inches thick. The subsoil is about 32 inches thick. It is firm. It is gray silty clay in the upper part and light brownish gray and light gray silty clay loam in the lower part. The underlying material to a depth of 60 inches is light gray silty clay loam.

Included with these soils in mapping are small areas of Cavour, Cresbard, Hamerly, and Nishon soils. These included soils make up less than 20 percent of this map unit. Cavour and Cresbard soils have a sodium-affected subsoil. They are in positions on the landscape similar to those of the Svea soil. Hamerly soils are somewhat poorly drained and moderately well drained and are on toe slopes. They have lime at the surface. Nishon soils have a surface layer that is 1 to 4 inches thick. They are in positions on the landscape similar to those of the Tonka soil.

The content of organic matter is moderate in the Barnes soil and high in the Svea and Tonka soils. Fertility is medium in the Barnes soil and high in the Svea and Tonka soils. Permeability is moderate in the subsoil of the Barnes and Svea soils and moderately

slow in the underlying material. It is slow in the Tonka soil. Available water capacity is high in all three soils. During wet periods, the water table is at a depth of 4 to 6 feet in the Svea soil and is within a depth of 1 foot in the Tonka soil. As much as 0.5 foot of water may pond on the Tonka soil. Runoff is slow on the Barnes and Svea soils and ponded on the Tonka soil. The shrink-swell potential is moderate in the Barnes and Svea soils and high in the Tonka soil.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Garrison creeping foxtail and reed canarygrass also are suitable on the Tonka soil. Wheat, corn, barley, and sunflowers are the main crops. Because of runoff from the Barnes soil, planting and harvesting are delayed in some areas of the Svea and Tonka soils. Measures that conserve moisture in the Barnes soil and control ponding on the Tonka soil are the main management needs. Leaving crop residue on the surface and minimizing tillage conserve moisture. In most years planting is delayed on the Tonka soil because of the ponding. Surface drains help to remove the excess water.

No major hazards or limitations affect the use of the Barnes and Svea soils for range. Surface compaction is a problem on the Tonka soil during wet periods. Restricted grazing during these periods helps to prevent compaction. Many areas of the Tonka soil are potential sites for excavated ponds.

The Barnes and Svea soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Barnes soil, except for those that require an abundant supply of moisture. The Svea soil is especially suited to the species that require an abundant supply of moisture. The Tonka soil is generally unsuited to windbreaks and environmental plantings unless it is drained.

The Barnes soil is suited to building site development, but the moderate shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. The Barnes soil is suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Svea and Tonka soils are generally unsuitable as sites for buildings and septic tank absorption fields because the Svea soil is subject to overland flow and the Tonka soil is subject to ponding.

The Barnes soil is in capability unit IIc-2, Silty range site, and windbreak suitability group 3; the Svea soil is in capability unit IIc-3, Overflow range site, and windbreak suitability group 1; the Tonka soil is in capability unit IVw-1, Wet Meadow range site, and windbreak suitability group 10.

BkB—Barnes-Svea-Tonka complex, 0 to 6 percent slopes. These deep, level to undulating soils are on till plains. The well drained Barnes soil is on back slopes, the moderately well drained Svea soil is on foot slopes, and the poorly drained Tonka soil is in basins. The Tonka soil is ponded during spring runoff and after heavy rains. Areas are irregular in shape and range from 40 to more than 1,000 acres in size. They are 35 to 45 percent Barnes soil, 20 to 30 percent Svea soil, and 10 to 15 percent Tonka soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is dark gray loam about 7 inches thick. The subsoil is about 33 inches thick. It is friable. It is brown clay loam and pale brown loam in the upper part and light brownish gray, calcareous loam in the lower part. The underlying material to a depth of 60 inches is light brownish gray, calcareous loam. In places the subsoil contains more clay.

Typically, the surface layer of the Svea soil is dark gray loam about 8 inches thick. The subsurface layer also is dark gray loam. It is about 7 inches thick. The subsoil is about 21 inches thick. It is friable. The upper part is grayish brown loam, and the lower part is pale yellow, calcareous clay loam. The underlying material to a depth of 60 inches is light yellowish brown, calcareous clay loam. In some places the subsoil contains more clay. In other places the surface layer and subsoil are thicker.

Typically, the surface layer of the Tonka soil is gray silt loam about 9 inches thick. The subsurface layer is light gray silt loam about 9 inches thick. The subsoil is about 32 inches thick. It is firm. It is gray silty clay in the upper part and light brownish gray and light gray silty clay loam in the lower part. The underlying material to a depth of 60 inches is light gray silty clay loam.

Included with these soils in mapping are small areas of Buse, Cresbard, Hamerly, and Nishon soils. These included soils make up less than 20 percent of this map unit. The well drained Buse soils are on the upper back slopes and shoulder slopes. They have lime at or near the surface. Cresbard soils have a sodium-affected subsoil. They are in positions on the landscape similar to those of the Svea soil. The moderately well drained and somewhat poorly drained Hamerly soils are on toe slopes. They have lime at the surface. Nishon soils have a surface layer that is 1 to 4 inches thick. They

are in positions on the landscape similar to those of the Tonka soil.

The content of organic matter is moderate in the Barnes soil and high in the Svea and Tonka soils. Fertility is medium in the Barnes soil and high in the Svea and Tonka soils. Permeability is moderate in the subsoil of the Barnes and Svea soils and moderately slow in the underlying material. It is slow in the Tonka soil. Available water capacity is high in all three soils. During wet periods, the water table is at a depth of 4 to 6 feet in the Svea soil and is within a depth of 1 foot in the Tonka soil. As much as 0.5 foot of water may pond on the Tonka soil. Runoff is medium on the Barnes soil, slow on the Svea soil, and ponded on the Tonka soil. The shrink-swell potential is moderate in the Barnes and Svea soils and high in the Tonka soil.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Garrison creeping foxtail and reed canarygrass also are suitable on the Tonka soil. Wheat, corn, barley, and sunflowers are the main crops. Because of runoff from the Barnes soil, planting and harvesting are delayed in some areas of the Svea and Tonka soils. Measures that control erosion and conserve moisture in areas of the Barnes soil and control ponding on the Tonka soil are the main management needs. Leaving crop residue on the surface and minimizing tillage help to control erosion and conserve moisture. Contour farming, grassed waterways, and terraces can help to control erosion, but in most areas the slopes are too short or too irregular for contouring and terracing. In most years planting is delayed on the Tonka soil because of the ponding. Surface drains help to remove the excess water.

No major hazards or limitations affect the use of the Barnes and Svea soils for range. Surface compaction is a problem on the Tonka soil during wet periods. Restricted grazing during these periods helps to prevent compaction. Many areas of the Tonka soil are potential sites for excavated ponds.

The Barnes and Svea soils are suited to windbreaks and environmental plantings (fig. 8). All climatically suited trees and shrubs grow well on the Barnes soil, except for those that require an abundant supply of moisture. The Svea soil is especially suited to the species that require an abundant supply of moisture. The Tonka soil is generally unsuited to windbreaks and environmental plantings unless it is drained.

The Barnes soil is suited to building site development, but the moderate shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. The Barnes soil is suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Svea and Tonka soils are generally unsuited to building site development and septic tank absorption fields because the Svea soil is subject to overland flow and the Tonka soil is subject to ponding.

The Barnes soil is in capability unit IIe-2, Silty range site, and windbreak suitability group 3; the Svea soil is in capability unit IIc-3, Overflow range site, and windbreak suitability group 1; the Tonka soil is in capability unit IVw-1, Wet Meadow range site, and windbreak suitability group 10.

BmB—Barnes-Tally complex, 2 to 6 percent slopes. These deep, well drained, gently undulating and undulating soils are on till plains. The Barnes soil is on the upper back slopes and summits, and the Tally soil is on the lower back slopes. Areas are elongated or irregularly shaped and range from 10 to 75 acres in size. They are 45 to 55 percent Barnes soil and 20 to 30 percent Tally soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is dark gray loam about 7 inches thick. The subsoil is about 33 inches thick. It is friable. It is brown clay loam and pale brown loam in the upper part and light brownish gray, calcareous loam in the lower part. The underlying material to a depth of 60 inches is light brownish gray, calcareous loam.

Typically, the surface layer of the Tally soil is dark grayish brown fine sandy loam about 8 inches thick. The subsoil is fine sandy loam about 35 inches thick. It is very friable. The upper part is dark grayish brown and brown. The lower part is grayish brown and light brownish gray and is calcareous. The upper part of the underlying material is light yellowish brown, calcareous fine sandy loam. The lower part to a depth of 60 inches is light yellowish brown, calcareous clay loam.

Included with these soils in mapping are small areas of Buse, Embden, Letcher, Noonan, and Svea soils. These included soils make up less than 25 percent of this map unit. Buse soils have lime at or near the surface. They are on shoulder slopes. Embden, Letcher, Noonan, and Svea soils are on foot slopes. Embden and Svea soils are dark to a depth of more than 16 inches. Letcher and Noonan soils have a sodium-affected subsoil.

The content of organic matter is moderate in the Barnes and Tally soils, and fertility is medium.

Figure 8.—A farmstead windbreak in an area of Barnes-Svea-Tonka complex, 0 to 6 percent slopes.

Permeability is moderate in the subsoil of the Barnes soil and moderately slow in the underlying material. It is moderately rapid in the sandy part of the Tally soil and moderately slow in the underlying material. Available water capacity is high in the Barnes soil and moderate in the Tally soil. Runoff is medium on the Barnes soil and slow on the Tally soil. The shrink-swell potential is moderate in the Barnes soil. It is low in the sandy part of the Tally soil and moderate in the underlying material.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, oats, and alfalfa are the main crops. Controlling erosion and conserving moisture are the main management needs. Minimizing tillage, leaving crop residue on the surface, and including grasses and legumes in the cropping sequence help to control erosion, conserve moisture, and increase the content of organic matter.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on these soils, except for those that require an abundant supply of moisture.

These soils are suited to building site development, but the moderate shrink-swell potential in the Barnes soil and in the underlying material of the Tally soil is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. The upper part of the Tally soil readily absorbs the effluent, but permeability is restricted in the underlying material. Enlarging the absorption area helps to overcome a slow absorption rate. In areas of the Tally soil, the sides of shallow excavations tend to cave in unless they are shored.

The Barnes soil is in capability unit IIe-2, Silty range site, and windbreak suitability group 3; the Tally soil is in capability unit IIIe-8, Sandy range site, and windbreak suitability group 5.

BnA—Barnes-Urban land complex, 0 to 3 percent slopes. This map unit consists of a deep, level and gently undulating, well drained Barnes soil intermingled with areas of Urban land. The unit is on till plains. It is in built-up areas in the city of Aberdeen. Areas range from 25 to 500 acres in size and are irregular in shape. They are 45 to 55 percent Barnes soil and 25 to 40 percent Urban land. The Barnes soil and the Urban land occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is dark gray loam about 7 inches thick. The subsoil is about 33 inches thick. It is friable. It is brown clay loam and pale brown loam in the upper part and light brownish gray, calcareous loam in the lower part. The underlying material to a depth of 60 inches is light brownish gray, calcareous loam.

The Urban land is covered by streets, parking lots, buildings, sidewalks, driveways, patios, and other structures that so obscure or alter the soils that identification of the soil series is not feasible. Most of the structures are single-unit dwellings. Other than site preparation before construction, little alteration has taken place on the Barnes soil.

Included in mapping are small areas of Cresbard, Hamerly, Svea, and Tonka soils. These soils make up less than 20 percent of this map unit. Cresbard soils have a sodium-affected subsoil. They are on foot slopes. The moderately well drained and somewhat poorly drained Hamerly soils are on toe slopes. They have lime at the surface. The moderately well drained Svea soils are on foot slopes. The poorly drained Tonka soils are in basins.

The content of organic matter is moderate in the Barnes soil, and fertility is medium. Permeability is moderate in the subsoil and moderately slow in the underlying material. Available water capacity is high. Runoff is slow or medium. The shrink-swell potential is moderate.

The Barnes soil is used for building site development, lawns, open areas, gardens, or parks. It is suited to grasses, flowers, vegetables, trees, and shrubs. The main management needs are measures that conserve moisture. Tillage practices that leave crop residue on the surface and minimum tillage are examples. All climatically suited trees and shrubs grow well, except for those that require an abundant supply of moisture.

Among the management concerns affecting urban development are cracking and shifting of structures because of the moderate shrink-swell potential, failure of steel because of corrosivity, and failure of septic tank absorption fields. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

The Barnes soil is suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate. Onsite investigation is needed if development is planned.

No capability unit, range site, or windbreak suitability group is assigned.

Bo—Bearden silt loam. This deep, somewhat poorly drained, level and nearly level soil is on glacial lake plains. Areas are irregular in shape and range from 5 to 150 acres in size. Slopes are smooth.

Typically, the surface layer is dark gray, calcareous silt loam about 8 inches thick. Below this is a transitional layer of gray, calcareous silt loam about 4 inches thick. The subsoil is light gray, friable, calcareous silt loam about 27 inches thick. The lower part has nests and crystals of salt. The underlying material to a depth of 60 inches is pale yellow, calcareous silt loam.

Included with this soil in mapping are small areas of Beotia, Colvin, and Tonka soils. These soils make up less than 15 percent of this map unit. The well drained Beotia soils are on the slightly higher parts of the landscape. They are dark to a depth of more than 16 inches. The poorly drained and very poorly drained Colvin soils are on the slightly lower parts of the landscape. The poorly drained Tonka soils are in basins.

The content of organic matter is moderate in the Bearden soil, and fertility is medium. Permeability is moderate to slow. Available water capacity is high. The water table is at a depth of 2 to 4 feet early in spring and during other wet periods. Runoff is slow. The shrink-swell potential is moderate.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Alfalfa, intermediate wheatgrass, and smooth brome are suitable pasture plants. Wheat, corn, and barley are the main crops. A high content of lime in the surface layer restricts the availability of plant nutrients and increases the susceptibility to wind erosion. The main management needs are measures that control wind erosion and maintain fertility. Tillage practices that leave crop residue on the surface and minimum tillage are examples. Stripcropping also helps to control wind erosion.

No major hazards or limitations affect the use of this soil for range. Proper stocking rates, timely deferment

of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, especially those that require an abundant supply of moisture.

This soil is generally unsuited to building site development and septic tank absorption fields because of the wetness.

This soil is in capability unit IIe-4, Limy Subirrigated range site, and windbreak suitability group 1.

Bp—Bearden silt loam, saline. This deep, somewhat poorly drained, level and nearly level soil is on glacial lake plains. Areas are irregular in shape and range from 5 to 80 acres in size. Slopes are smooth.

Typically, the surface layer is dark gray, calcareous silt loam about 8 inches thick. It has nests and seams of salt. The subsoil is white, friable, calcareous silt loam about 17 inches thick. It has nests and seams of salt. The upper part of the underlying material is light gray, calcareous silt loam that has many nests of gypsum. The lower part to a depth of 60 inches is pale yellow, calcareous silt loam.

Included with this soil in mapping are small areas of Colvin soils. These soils make up less than 10 percent of this map unit. The poorly drained and very poorly drained Colvin soils are in the slightly lower positions on the landscape.

The content of organic matter is moderate in the Bearden soil, and fertility is low. Permeability is moderate to slow. Available water capacity is moderate. The water table is at a depth of 2 to 4 feet early in spring and during other wet periods. Runoff is slow. The shrink-swell potential is moderate.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Tall wheatgrass and switchgrass are suitable pasture plants. Barley is the main crop. The salinity and a high content of lime in the surface layer restrict the availability of plant nutrients and increase the susceptibility to wind erosion. Measures that control wind erosion and improve fertility are the main management needs. Tillage practices that leave crop residue on the surface and minimum tillage are examples. Stripcropping also helps to control wind erosion.

Some areas support native grasses and are used for grazing. The salinity limits productivity and the variety of suitable grasses.

This soil is generally unsuited to windbreaks and environmental plantings because of the high content of salt.

This soil is generally unsuited to building site development and septic tank absorption fields because of the wetness. Sites that are better suited generally are available on the adjacent uplands.

This soil is in capability unit IIIs-6, Saline Subirrigated range site, and windbreak suitability group 10.

BrB—Bearden-Huffton silt loams, 1 to 6 percent slopes. These deep, very gently sloping and gently sloping soils are along drainageways on glacial lake plains. The somewhat poorly drained Bearden soil is on the upper toe slopes, and the well drained Huffton soil is on back slopes. Areas are elongated and range from 10 to 100 acres in size. They are 45 to 55 percent Bearden soil and 35 to 45 percent Huffton soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Bearden soil is dark gray, calcareous silt loam about 8 inches thick. Below this is a transitional layer of gray, calcareous silt loam about 4 inches thick. The subsoil is light gray, friable, calcareous silt loam about 27 inches thick. The lower part has nests and crystals of salt. The underlying material to a depth of 60 inches is pale yellow, calcareous silt loam. In places the soil is more saline.

Typically, the surface layer of the Huffton soil is dark grayish brown, calcareous silt loam about 7 inches thick. The subsoil is calcareous, very friable silt loam about 23 inches thick. The upper part is grayish brown and light gray. The lower part is light gray and pale yellow and has nests of gypsum and other salts. The underlying material to a depth of 60 inches is pale yellow and light gray, calcareous silt loam. It is varved in the lower part.

Included with these soils in mapping are small areas of Beotia, Great Bend, and Zell soils. These included soils make up less than 10 percent of this map unit. Beotia soils are dark to a depth of more than 16 inches. They are on the upper foot slopes. Great Bend and Zell soils have a lower content of salts than the Bearden and Huffton soils. Great Bend soils are in positions on the landscape similar to those of the Huffton soil. Zell soils are on shoulder slopes.

The content of organic matter is moderate in the Bearden and Huffton soils. Fertility is medium in the Bearden soil and low in the Huffton soil. Permeability is moderate to slow in the Bearden soil. It is moderate in the upper part of the Huffton soil and moderate to slow in the underlying material. Available water capacity is high in the Bearden soil and moderate in the Huffton soil. The Bearden soil has a water table at a depth of 2 to 4 feet during wet periods. Runoff is slow on the Bearden soil and medium on the Huffton soil. The shrink-swell potential is moderate in the Bearden soil and low in the Huffton soil.

Almost all of the acreage is cropland. These soils are

suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, barley, and corn are the main crops. A high content of lime in the surface layer restricts the availability of plant nutrients in both soils, and high salinity in the Huffton soil increases the susceptibility to wind erosion, restricts the availability of plant nutrients, and decreases the available water capacity. Measures that control erosion, conserve moisture, and improve fertility are the main management needs. Leaving crop residue on the surface, minimizing tillage, and including grasses and legumes in the cropping sequence are examples. Contour farming and terraces can help to control erosion, but in most areas the slopes are too short for terracing.

Some areas support native grasses and are used for grazing. No major hazards or limitations affect the use of the Bearden soil for range. The high salinity in the Huffton soil limits the choice of species and restricts plant growth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Bearden soil, especially those that require an abundant supply of moisture. The high content of lime and salts in the root zone of the Huffton soil limits the selection of adapted species. Trees and shrubs can be established on this soil, but optimum survival, growth, and vigor are unlikely.

These soils are suited to building site development, but the wetness and the moderate shrink-swell potential are limitations in the Bearden soil. Draining the site, backfilling with sandy material, and reinforcing the footings and foundations help to prevent the structural damage caused by shrinking and swelling and by wetness.

The Bearden soil is generally unsuitable as a site for septic tank absorption fields because of the wetness. The Huffton soil is suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate. Sites that are better suited to this use generally are available in the adjacent areas.

The Bearden soil is in capability unit IIe-4, Limy Subirrigated range site, and windbreak suitability group 1; the Huffton soil is in capability unit IVe-2, Thin Upland range site, and windbreak suitability group 8.

BsB—Bearden-Huffton-Putney silt loams, 1 to 4 percent slopes. These deep, very gently sloping and gently sloping, nearly level to undulating soils are on glacial lake plains. The somewhat poorly drained Bearden soil is on the upper toe slopes, the well drained Huffton soil is on back slopes, and the well drained Putney soil is on the upper foot slopes. Areas are irregular in shape and range from 20 to 200 acres in size. They are 35 to 50 percent Bearden soil, 15 to 35 percent Huffton soil, and 10 to 20 percent Putney soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Bearden soil is dark gray, calcareous silt loam about 8 inches thick. It has nests and seams of salt. The subsoil is white, friable, calcareous silt loam about 17 inches thick. It has nests and threads of salt throughout and a few nests of gypsum in the lower part. The upper part of the underlying material is light gray, calcareous silt loam that has many nests of gypsum. The lower part to a depth of 60 inches is pale yellow, calcareous silt loam. In places the soil contains less salt.

Typically, the surface layer of the Huffton soil is dark grayish brown, calcareous silt loam about 7 inches thick. The subsoil is calcareous, very friable silt loam about 23 inches thick. The upper part is grayish brown and light gray. The lower part is light gray and pale yellow and has nests of gypsum and other salts. The underlying material to a depth of 60 inches is pale yellow and light gray, calcareous silt loam. It is varved in the lower part.

Typically, the surface layer of the Putney soil is dark gray silt loam about 8 inches thick. The subsoil is about 17 inches thick. It is friable. The upper part is grayish brown silty clay loam. The lower part is light gray, calcareous silty clay loam and silt loam and has nests of gypsum and other salts. The underlying material to a depth of 60 inches is pale yellow, calcareous silt loam. It is varved in the lower part.

Included with these soils in mapping are small areas of Beotia, Tonka, Winship, and Zell soils. These included soils make up less than 15 percent of this map unit. The well drained Beotia soils are dark to a depth of more than 16 inches. They are in positions on the landscape similar to those of the Putney soil. The poorly drained Tonka soils are in basins. The somewhat poorly drained Winship soils do not have lime near the surface. They are in positions on the landscape similar to those of the Bearden soil. Zell soils do not have salts within a depth of 20 inches. They are in positions on the landscape similar to those of the Huffton soil.

The content of organic matter is moderate in the Bearden, Huffton, and Putney soils. Fertility is low in the Bearden and Huffton soils and medium in the Putney soil. Permeability is moderate to slow in the Bearden soil. It is moderate in the upper part of the Huffton and Putney soils and moderate to slow in the underlying

material. Available water capacity is moderate in the Bearden and Huffton soils and high in the Putney soil. During wet periods a seasonal high water table is at a depth of 2 to 4 feet in the Bearden soil. Runoff is slow on the Bearden and Putney soils and medium on the Huffton soil. The shrink-swell potential is moderate in the Bearden soil and low in the Huffton soil. It is moderate in the subsoil of the Putney soil and low in the underlying material.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are tall wheatgrass and switchgrass on the Bearden soil and alfalfa, intermediate wheatgrass, and smooth brome on the Huffton and Putney soils. Wheat, barley, and corn are the main crops. The high content of salts in all three soils and a high content of lime in the surface layer of the Bearden and Huffton soils restrict the availability of plant nutrients and the available water capacity and increase the susceptibility to wind erosion. Measures that improve fertility, conserve moisture, and control erosion are the main management needs. Examples are minimizing tillage, leaving crop residue on the surface, applying animal manure, and including grasses and legumes in the cropping sequence.

Some areas support native grasses and are used for grazing. The high salinity in the Bearden and Huffton soils limits productivity and the variety of suitable grasses. No major hazards or limitations affect the use of the Putney soil for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

The Bearden soil is generally unsuited to windbreaks and environmental plantings because of the high salinity. The Huffton and Putney soils are suited to windbreaks and environmental plantings. The high content of lime and salts in the surface layer of the Huffton soil is a limitation. Trees and shrubs can be established on this soil, but optimum survival, growth, and vigor are unlikely. All climatically suited trees and shrubs grow well on the Putney soil, except for those that require an abundant supply of moisture.

These soils are suited to building site development, but the wetness and the moderate shrink-swell potential are limitations in the Bearden soil. Draining the site, backfilling with sandy material, and reinforcing the footings and foundations help to prevent the structural damage caused by wetness and by shrinking and swelling.

The Bearden soil is generally unsuited to septic tank absorption fields because of the wetness. The Huffton and Putney soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Bearden soil is in capability unit IIIs-6, Saline Subirrigated range site, and windbreak suitability group 10; the Huffton soil is in capability unit IVe-2, Thin Upland range site, and windbreak suitability group 8; the Putney soil is in capability unit IIe-5, Silty range site, and windbreak suitability group 3.

Bt—Beotia silt loam, 0 to 2 percent slopes. This deep, well drained, level and nearly level soil is on glacial lake plains. Areas are irregular in shape and range from 60 to more than 500 acres in size. Slopes are long and smooth.

Typically, the surface layer is dark gray silt loam about 7 inches thick. The subsurface layer also is dark gray silt loam. It is about 4 inches thick. The subsoil is about 31 inches thick. It is friable. The upper part is grayish brown silty clay loam and silt loam. The lower part is pale yellow, calcareous silt loam. The underlying material to a depth of 60 inches is pale yellow, calcareous silt loam varved with very fine sandy loam and silty clay. In places the dark surface soil is thinner.

Included with this soil in mapping are small areas of Bearden, Harmony, and Winship soils. These soils make up less than 15 percent of this map unit. The somewhat poorly drained Bearden and Winship soils are on the lower toe slopes. Bearden soils have free lime at the surface. Harmony soils have more clay than the Beotia soil. They are in positions on the landscape similar to those of the Beotia soil.

The content of organic matter and fertility are high in the Beotia soil. Available water capacity also is high. Permeability is moderate in the subsoil and moderate to slow in the underlying material. Runoff is slow. The shrink-swell potential is moderate in the subsoil and low in the underlying material.

Almost all of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, oats, soybeans, and sunflowers are the main crops. The main management needs are measures that conserve moisture. Leaving crop residue on the surface and minimizing tillage are examples.

No major hazards or limitations affect the use of this soil for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to windbreaks and environmental plantings. Except for the species that require an abundant supply of moisture, all climatically suited trees and shrubs grow well.

This soil is suited to building site development, but the moderate shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

This soil is suited to septic tank absorption fields, but the restricted permeability is a limitation. The varves in the underlying material result in the slow absorption of liquid waste. Enlarging the absorption area helps to overcome the slow absorption rate.

This soil is in capability unit IIc-3, Silty range site, and windbreak suitability group 3.

Bv—Beotia-Rondell silt loams, 0 to 3 percent slopes. These deep, level to very gently sloping soils are on glacial lake plains. The well drained Beotia soil is on foot slopes, and the moderately well drained Rondell soil is on the lower foot slopes. Areas are irregular in shape and range from 20 to 200 acres in size. They are 40 to 55 percent Beotia soil and 20 to 40 percent Rondell soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Beotia soil is dark gray silt loam about 7 inches thick. The subsurface layer also is dark gray silt loam. It is about 4 inches thick. The subsoil is about 31 inches thick. It is friable. The upper part is grayish brown silty clay loam and silt loam. The lower part is pale yellow, calcareous silt loam. The underlying material to a depth of 60 inches is pale yellow, calcareous silt loam. It is varved in the lower part. In places the dark surface soil is thinner.

Typically, the surface layer of the Rondell soil is dark gray, calcareous silt loam about 7 inches thick. The subsurface layer also is dark gray, calcareous silt loam. It is about 5 inches thick. The subsoil is white, friable silt loam about 23 inches thick. The underlying material to a depth of 60 inches is light gray and light yellowish brown, calcareous silt loam. It is varved in the lower part.

Included with these soils in mapping are small areas of Bearden, Harmony, Putney, Tonka, and Winship soils. These included soils make up less than 20 percent of this map unit. The somewhat poorly drained Bearden soils are slightly lower on the landscape than the Rondell soil. Harmony soils contain more clay and less silt in the subsoil than the Beotia soil. They are in positions on the landscape similar to those of the Beotia soil. Putney soils have salts within a depth of 20 inches. They are in the slightly higher positions on the landscape. The poorly drained Tonka soils are in small basins. The somewhat poorly drained Winship soils are in positions on the landscape similar to those of the Rondell soil. They contain more clay in the subsoil than the Rondell soil.

The content of organic matter is high in the Beotia soil and moderate in the Rondell soil. Fertility is high in the Beotia soil and medium in the Rondell soil. Permeability is moderate in the subsoil of both soils and moderate to slow in the underlying material. Available water capacity is high. The Rondell soil has a water table at a depth of 4 to 6 feet during wet periods. Runoff is slow on both soils. The shrink-swell potential is moderate in the subsoil of both soils and low in the underlying material.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, barley, soybeans, and oats are the main crops. The main management concerns are conserving moisture on the Beotia soil and controlling wind erosion and maintaining fertility on the Rondell soil. A high content of lime in the upper part of the Rondell soil restricts the availability of plant nutrients and increases the susceptibility to wind erosion. Leaving crop residue on the surface, minimizing tillage, and stripcropping conserve moisture, help to maintain fertility, and help to control wind erosion.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings, but the high content of lime in the surface layer of the Rondell soil is a limitation. Except for the species that require an abundant supply of moisture, all climatically suited trees and shrubs grow well on the Beotia soil. Trees and shrubs can be established on the Rondell soil, but optimum survival, growth, and vigor are unlikely.

These soils are suited to most building site development, but the moderate shrink-swell potential is a limitation. Wetness also is a limitation on the Rondell soil. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. The varves in the underlying material result in the slow absorption of liquid waste. Enlarging the absorption area helps to overcome the slow absorption rate.

The Beotia soil is in capability unit IIc-3, Silty range

site, and windbreak suitability group 3; the Rondell soil is in capability unit IIe-4, Limy Subirrigated range site, and windbreak suitability group 8.

Bw—Beotia-Urban land complex, 0 to 2 percent slopes. This map unit consists of a deep, level and nearly level, well drained Beotia soil intermingled with areas of Urban land. The unit is on glacial lake plains. It is in built-up areas in the city of Aberdeen. Areas range from 20 to 300 acres in size and are irregular in shape. They are 45 to 55 percent Beotia soil and 25 to 40 percent Urban land. The Beotia soil and the Urban land occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Beotia soil is dark gray silt loam about 7 inches thick. The subsurface layer also is dark gray silt loam. It is about 4 inches thick. The subsoil is about 31 inches thick. It is friable. The upper part is grayish brown silty clay loam and silt loam. The lower part is pale yellow, calcareous silt loam. The underlying material to a depth of 60 inches is pale yellow, calcareous silt loam varved with very fine sandy loam and silty clay. In places the dark surface soil is thinner.

The Urban land is covered by streets, parking lots, buildings, sidewalks, driveways, patios, and other structures that so obscure or alter the soils that identification of the soil series is not feasible. Most of the structures are single-unit dwellings, but about 15 percent of them are multiple-unit dwellings, businesses, and shopping centers on sites that have paved parking lots. Because of the flat topography, much of the landscape has not been greatly disturbed during construction.

Included in mapping are small areas of Bearden, Harmony, and Winship soils. These soils make up 10 to 20 percent of this map unit. The somewhat poorly drained Bearden and Winship soils are on the lower toe slopes. Bearden soils have lime at the surface. Harmony soils have more clay than the Beotia soil. They are in positions on the landscape similar to those of the Beotia soil.

The content of organic matter is high in the Beotia soil. Fertility and available water capacity also are high. Permeability is moderate in the subsoil and moderate to slow in the underlying material. Runoff is slow. The shrink-swell potential is moderate in the subsoil and low in the underlying material.

The Beotia soil is used for building site development, lawns, open areas, gardens, or parks. It is suited to grasses, flowers, vegetables, trees, and shrubs. Measures that conserve moisture and improve fertility are the main management needs. Except for the species that require an abundant supply of moisture, all climatically suited trees and shrubs grow well.

The Beotia soil is suited to building site development, but the moderate shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

The Beotia soil is suited to septic tank absorption fields, but the restricted permeability is a limitation. The varves in the underlying material result in the slow absorption of liquid waste. Enlarging the absorption area helps to overcome the slow absorption rate. Where possible, sanitary facilities should be connected to commercial sewers and treatment facilities. Onsite investigation is needed if development is planned.

No capability unit, range site, or windbreak suitability group is assigned.

Bx—Beotia-Winship silt loams. These deep, level and nearly level soils are on glacial lake plains. The moderately well drained Beotia soil is on foot slopes, and the somewhat poorly drained Winship soil is on the lower toe slopes. Areas are elongated and narrow and range from 15 to 130 acres in size. They are 60 to 70 percent Beotia soil and 15 to 25 percent Winship soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Beotia soil is dark gray silt loam about 7 inches thick. The subsurface layer also is dark gray silt loam. It is about 4 inches thick. The subsoil is about 31 inches thick. It is friable. It is grayish brown silty clay loam and silt loam in the upper part and pale yellow, calcareous silt loam in the lower part. The underlying material to a depth of 60 inches is pale yellow, calcareous silt loam varved with very fine sandy loam and silty clay.

Typically, the surface layer of the Winship soil is dark gray silt loam about 7 inches thick. The subsurface layer also is dark gray silt loam. It is about 15 inches thick. Below this is a transitional layer about 11 inches thick. This layer is silty clay loam that has light gray coatings on faces of peds. The subsoil is gray and light brownish gray, friable silty clay loam about 15 inches thick. The underlying material to a depth of 60 inches is light gray silt loam.

Included with these soils in mapping are small areas of Bearden, Great Bend, Harmony, and Tonka soils. These included soils make up less than 15 percent of this map unit. The somewhat poorly drained Bearden soils are in positions on the landscape similar to those of the Winship soil. They have lime at or near the surface. The well drained Great Bend soils are on the slightly higher parts of the landscape. Harmony soils

contain more clay than the Beotia and Winship soils. They are in positions on the landscape similar to those of the Beotia soil. The poorly drained Tonka soils are in basins.

The content of organic matter is high in the Beotia and Winship soils. Fertility also is high. Permeability is moderate in the subsoil of the Beotia soil and moderate to slow in the underlying material. It is moderately slow in the subsoil of the Winship soil and moderately slow or slow in the underlying material. Available water capacity is high in both soils. During wet periods, the Beotia soil has a water table at a depth of 4 to 6 feet and the Winship soil has one at a depth of 2 to 4 feet. Runoff is slow on both soils. The shrink-swell potential is moderate in the subsoil of the Beotia soil and low in the underlying material. It is moderate in the Winship soil.

Most of the acreage is cultivated. These soils are suited to cultivated crops and to tame pasture and hay Alfalfa, intermediate wheatgrass, and smooth brome are suitable pasture plants. Wheat, corn, oats, soybeans, and sunflowers are the main crops. Measures that conserve moisture are the main management needs. Leaving crop residue on the surface and minimizing tillage are examples. Because of runoff from the adjacent soils, planting and harvesting may be delayed during wet periods. The additional moisture is beneficial, however, in most years.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, especially those that require an abundant supply of moisture.

These soils are generally unsuited to building site development and septic tank absorption fields because of the wetness.

The Beotia soil is in capability unit IIc-3, Overflow range site, and windbreak suitability group 1; the Winship soil is in capability unit IIw-1, Overflow range site, and windbreak suitability group 1.

By—Borup silt loam. This deep, poorly drained, level and nearly level soil is on glacial lake plains. It is subject to rare flooding. Areas are irregular in shape and range from 10 to 100 acres in size. Slopes are concave and smooth.

Typically, the surface layer is dark gray, calcareous silt loam about 8 inches thick. The subsurface layer also is dark gray, calcareous silt loam about 8 inches thick. The subsoil is about 30 inches thick. It is very friable and calcareous. It is gray very fine sandy loam in the upper part and light gray loamy very fine sand in the lower part. The underlying material to a depth of 60 inches is light gray, calcareous loamy very fine sand. In places the soil contains more clay.

Included with this soil in mapping are small areas of Glyndon, Stirum, and Wyndmere soils. These soils make up less than 15 percent of this map unit. The moderately well drained Glyndon and somewhat poorly drained Wyndmere soils are slightly higher on the landscape than the Borup soil. Stirum soils have a sodium-affected subsoil. They are slightly lower on the landscape than the Borup soil.

The content of organic matter is high in the Borup soil, and fertility is medium. Permeability is moderately rapid. Available water capacity is moderate or high. The water table is at a depth of 1.0 to 2.5 feet during wet periods. Runoff is very slow. The shrink-swell potential is low.

About half of the acreage supports native grasses and is used for grazing. This soil is better suited to range than to cropland. Grazing during wet periods causes compaction of the surface layer. Deferred grazing during wet periods, proper stocking rates, and rotation grazing help to prevent compaction and maintain maximum productivity.

This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, Garrison creeping foxtail, intermediate wheatgrass, and reed canarygrass. Barley, wheat, and corn are the main crops. Wetness is a limitation. A high content of lime in the surface layer restricts the availability of plant nutrients. Measures that maintain fertility and reduce the wetness are the main management needs. Leaving crop residue on the surface, minimizing tillage, and including grasses and legumes in the cropping sequence help to maintain fertility. Surface drains help to remove excess water. Diverting runoff from the adjacent soils also reduces the wetness.

This soil is generally unsuited to windbreaks and environmental plantings, building site development, and septic tank absorption fields because of the wetness.

This soil is in capability unit IVw-3, Subirrigated range site, and windbreak suitability group 10.

Bz—Borup silt loam, saline. This deep, poorly drained, level and nearly level soil is on glacial lake plains. It is subject to rare flooding after periods of heavy rainfall or snowmelt. Areas are irregular in shape and range from 10 to 200 acres in size. Slopes are concave and smooth.

Typically, the surface layer is dark gray, calcareous silt loam about 8 inches thick. The subsurface layer also is dark gray, calcareous silt loam about 8 inches

thick. The subsoil is about 30 inches thick. It is very friable and calcareous. It is gray very fine sandy loam in the upper part and light gray loamy very fine sand in the lower part. The underlying material to a depth of 60 inches is light gray, calcareous loamy very fine sand that has many mottles. The soil has nests of salt throughout. In places it contains more clay.

Included with this soil in mapping are small areas of Glyndon, Stirum, and Wyndmere soils. These soils make up less than 15 percent of this map unit. The moderately well drained Glyndon and somewhat poorly drained Wyndmere soils are slightly higher on the landscape than the Borup soil. Stirum soils have a sodium-affected subsoil. They are slightly lower on the landscape than the Borup soil.

The content of organic matter is high in the Borup soil, and fertility is low. Permeability is moderately rapid. Available water capacity is moderate. The water table is within a depth of 1 foot during wet periods. Runoff is very slow. The shrink-swell potential is low.

Most of the acreage is range and is used for grazing. The wetness and the high content of salts reduce the vigor of all species that are not tolerant of salt. Grazing during wet periods causes compaction of the surface layer, which results in an increase in the extent of the less desirable grasses and of weeds. Deferred grazing during wet periods, proper stocking rates, and rotation grazing help to prevent compaction and maintain maximum productivity.

This soil is suited to tame pasture and hay, but the choice of pasture plants is limited because of the high salinity. The best suited pasture plants are tall wheatgrass and switchgrass.

This soil is generally unsuited to cultivated crops, windbreaks and environmental plantings, building site development, and septic tank absorption fields because of the wetness and the high content of salts.

This soil is in capability unit IVw-4, Saline Subirrigated range site, and windbreak suitability group 10.

BzGA—Brantford Variant loam, 0 to 2 percent slopes. This well drained, level and nearly level soil is on outwash plains and terraces. It is shallow to shaly and sandy sediments. Areas are irregular in shape and range from 10 to 150 acres in size. Slopes are smooth and slightly convex.

Typically, the surface layer is dark gray and dark grayish brown loam about 7 inches thick. The subsoil is brown, friable clay loam about 8 inches thick. The upper part of the underlying material is grayish brown very gravelly clay loam. The next part is light brownish gray very gravelly loam. The lower part to a depth of 60 inches is brown very gravelly coarse sand. The content of shale fragments in the underlying material is, by volume, 35 to 50 percent.

Included with this soil in mapping are small areas of Harriet, Ranslo, and Tally soils. These soils make up less than 15 percent of this map unit. Harriet and Ranslo soils have a sodium-affected subsoil. They are on flood plains. Tally soils do not have gravelly sand in the underlying material. They are in the slightly higher positions on the landscape.

The content of organic matter is moderate in the Brantford Variant soil, and fertility is medium. Permeability is moderate in the subsoil and rapid or very rapid in the underlying material. Available water capacity is low or moderate. Runoff is slow. The shrink-swell potential is moderate in the subsoil and low in the underlying material.

About half of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay, but it is droughty because of the shallow depth to shaly and sandy sediments. The choice of pasture plants is limited by the low available water capacity and the shallow root zone. Crested wheatgrass is the best suited species. Small grain is the best suited crop because it matures early in the growing season. Wheat, barley, and oats are the main crops. Measures that conserve moisture are the main management needs. Examples are tillage practices that leave crop residue on the surface and minimum tillage.

Some areas support native grasses and are used for grazing. The shallow root zone and the low available water capacity limit productivity. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to windbreaks and environmental plantings, but the droughtiness is a limitation. Trees and shrubs can be established, but optimum survival, growth, and vigor are unlikely.

This soil is suited to most kinds of building site development, but the sides of shallow excavations tend to cave in unless they are shored.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. The soil is an improbable source of sand and gravel for use as road construction material because of the large amount of shale in the underlying material.

This soil is in capability unit IVs-1, Shallow to Gravel range site, and windbreak suitability group 6G.

BzHB—Brantford Variant-Vang loams, 2 to 6 percent slopes. These deep, well drained, gently sloping soils are on outwash plains and terraces. The Brantford Variant soil is on shoulder slopes and is

shallow to shaly and sandy sediments. The Vang soil is on back slopes. It is moderately deep over gravelly sand. In places scattered stones are on the surface. Areas are irregular in shape and range from 5 to 120 acres in size. They are 40 to 50 percent Brantford Variant soil and 30 to 40 percent Vang soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Brantford Variant soil is dark gray and dark grayish brown loam about 7 inches thick. The subsoil is brown, friable clay loam about 8 inches thick. The upper part of the underlying material is grayish brown very gravelly clay loam. The next part is light brownish gray very gravelly loam. The lower part to a depth of 60 inches is brown very gravelly coarse sand. The content of shale fragments in the underlying material is, by volume, 35 to 50 percent.

Typically, the surface layer of the Vang soil is dark gray loam about 7 inches thick. The subsoil is about 20 inches thick. The upper part is dark grayish brown and brown, very friable loam. The lower part is grayish brown, friable clay loam. The upper part of the underlying material is grayish brown clay loam. The lower part to a depth of 60 inches is light brownish gray gravelly sand. The content of shale fragments in the lower part of the underlying material is, by volume, 35 to 50 percent.

Included with these soils in mapping are small areas of Harriet, Ranslo, and Tally soils. These included soils make up less than 20 percent of this map unit. Harriet and Ranslo soils have a sodium-affected subsoil. They are on flood plains. Tally soils contain less clay in the subsoil and do not have gravelly sand in the underlying material. They are in positions on the landscape similar to those of the Brantford Variant soil.

The content of organic matter is moderate in the Brantford Variant and Vang soils, and fertility is medium. Permeability is moderate in the subsoil and rapid or very rapid in the underlying material. Available water capacity is low or moderate in the Brantford Variant soil and moderate in the Vang soil. Runoff is slow or medium on the Brantford Variant soil and slow on the Vang soil. The shrink-swell potential is moderate in the subsoil and low in the underlying material of both soils.

About half of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay, but the Brantford Variant soil is droughty because it is shallow to shaly and sandy sediments. The choice of pasture plants is limited by the low available water capacity and the shallow root zone in the Brantford Variant soil. Crested wheatgrass is the best suited species on the Brantford Variant soil. Alfalfa, crested wheatgrass, intermediate wheatgrass, and smooth brome are suitable on the Vang soil. Small grain is the best suited crop because it matures early in the growing season. Wheat, barley, and oats are the main crops. Measures that control erosion and conserve moisture are the main management needs. Examples are tillage practices that leave crop residue on the surface and minimum tillage.

Some areas support native grasses and are used for grazing. No major hazards or limitations affect the use of the Vang soil for range. The shallow root zone and the low available water capacity limit productivity on the Brantford Variant soil. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings, but the droughtiness is a limitation. Trees and shrubs can be established, but optimum survival, growth, and vigor are unlikely.

These soils are suited to most kinds of building site development, but the sides of shallow excavations tend to cave in unless they are shored.

These soils readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. The soils are an improbable source of sand and gravel for use as road construction material because of the large amount of shale in the underlying material.

The Brantford Variant soil is in capability unit IVe-6, Shallow to Gravel range site, and windbreak suitability group 6G; the Vang soil is in capability unit IIIe-6, Silty range site, and windbreak suitability group 6G.

BzVE—Buse-Barnes loams, 9 to 25 percent slopes. These deep, well drained, strongly sloping, rolling and hilly, and moderately steep soils are on moraines. The Buse soil is on shoulder slopes, and the Barnes soil is on the lower and middle back slopes. In places scattered stones are on the surface. Areas are long and narrow and range from 20 to 160 acres in size. They are 40 to 50 percent Buse soil and 35 to 45 percent Barnes soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Buse soil is dark gray, calcareous loam about 7 inches thick. The subsoil is pale brown, friable, calcareous loam about 15 inches thick. The underlying material to a depth of 60 inches is light yellowish brown, calcareous loam.

Typically, the surface layer of the Barnes soil is dark gray loam about 7 inches thick. The subsoil is about 33 inches thick. It is friable. It is brown clay loam and pale brown loam in the upper part and light brownish gray, calcareous loam in the lower part. The underlying

material to a depth of 60 inches is light brownish gray, calcareous loam.

Included with these soils in mapping are small areas of Renshaw, Svea, and Wabek Variant soils. These included soils make up less than 15 percent of this map unit. Renshaw soils have gravelly sand at a depth of 14 to 20 inches. They are in positions on the landscape similar to those of the Buse soil. The moderately well drained Svea soils are on foot slopes. The excessively drained Wabek Variant soils are in positions on the landscape similar to those of the Buse soil. They have gravelly sand at a depth of 7 to 14 inches.

The content of organic matter is low to moderate in the Buse soil and moderate in the Barnes soil. Fertility is low or medium in the Buse soil and medium in the Barnes soil. Permeability is moderately slow in the Buse soil. It is moderate in the subsoil of the Barnes soil and moderately slow in the underlying material. Available water capacity is high in both soils. Runoff is rapid. The shrink-swell potential is moderate.

Most of the acreage supports native grasses and is used for grazing. Water erosion is a hazard if the range is overgrazed. Gullies form along some cattle trails. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity and help to control water erosion.

These soils are generally unsuited to cultivated crops, tame pasture and hay, windbreaks and environmental plantings, building site development, and septic tank absorption fields because of the slope.

The Buse soil is in capability unit VIIe-3, Thin Upland range site, and windbreak suitability group 10; the Barnes soil is in capability unit VIe-1, Silty range site, and windbreak suitability group 10.

Ca—Camtown-Turton fine sandy loams, somewhat poorly drained. These deep, somewhat poorly drained, level and nearly level soils are on glacial lake plains. The Camtown soil is on the upper foot slopes, and the Turton soil is on the lower foot slopes. Both soils are frequently flooded for very brief periods. Areas are irregular in shape and range from 10 to 50 acres in size. They are 45 to 60 percent Camtown soil and 25 to 40 percent Turton soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Camtown soil is dark gray fine sandy loam about 10 inches thick. Below this is a mixed layer about 3 inches thick. This layer is grayish brown fine sandy loam that has light brownish gray silt coatings on faces of peds. The subsoil is friable loam about 24 inches thick. The upper part is grayish brown and brown, and the lower part is light gray and calcareous. The underlying material to a depth of 60 inches is light gray, calcareous loam.

Typically, the surface layer of the Turton soil is dark gray fine sandy loam about 7 inches thick. The subsurface layer also is dark gray fine sandy loam. It is about 8 inches thick. The next layer is gray very fine sandy loam about 4 inches thick. The subsoil is friable loam about 28 inches thick. The upper part is grayish brown. The lower part is grayish brown and light brownish gray and is calcareous. It has crystals and nests of salt. The underlying material to a depth of 60 inches is light gray, calcareous very fine sandy loam that has crystals of salt.

Included with these soils in mapping are small areas of Bearden, Egeland, Glyndon, and Tonka soils. These included soils make up less than 20 percent of this map unit. Bearden and Glyndon soils do not have a sodium-affected subsoil and have lime at the surface. They are in positions on the landscape similar to those of the Camtown soil. Egeland soils have less clay than the Camtown and Turton soils and do not have a sodium-affected subsoil. They are on the slightly higher parts of the landscape. The poorly drained Tonka soils are in basins.

The content of organic matter is moderate in the Camtown and Turton soils, and fertility is medium. Both soils have a sodium-affected subsoil. Tilth is good in the Camtown soil and poor in the Turton soil. Permeability is moderately slow or slow in the subsoil of the Camtown soil and moderate to slow in the underlying material. It is slow in the subsoil of the Turton soil and moderate to slow in the underlying material. Available water capacity is moderate or high in both soils. The water table is at a depth of 2 to 5 feet during wet periods. Runoff is slow. The shrink-swell potential is moderate in the subsoil and low in the underlying material.

Most areas are used as cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, and barley are the main crops. The flooding and the claypan subsoil in the Turton soil are limitations. The sodium-affected subsoil in both soils restricts crop growth by limiting root penetration and the rate of water intake. Planting or harvesting may be delayed during wet periods. Measures that improve tilth and increase the rate of water intake are the main management needs. Leaving crop residue on the surface, minimizing tillage, and including grasses and legumes in the cropping sequence are examples. Chiseling or subsoiling increases the rate of water intake and improves tilth.

If these soils are used for range, the claypan subsoil in the Turton soil limits productivity and the variety of

suitable grasses. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum production.

These soils are suited to windbreaks and environmental plantings, but the sodium-affected subsoil is a limitation. Trees and shrubs can be established, but optimum growth and survival are unlikely.

These soils are generally unsuited to building site development because of the flooding and the wetness. They are generally unsuited to septic tank absorption fields because of the wetness, the flooding, and the restricted permeability.

The Camtown soil is in capability unit IIIs-1, Clayey range site, and windbreak suitability group 4L; the Turton soil is in capability unit IVs-2, Claypan range site, and windbreak suitability group 9.

Cb—Camtown-Turton loams. These deep, moderately well drained, level and nearly level soils are on glacial lake plains. The Camtown soil is on back slopes, and the Turton soil is on the lower back slopes and upper foot slopes. Areas are irregular in shape and range from 20 to 175 acres in size. They are 45 to 60 percent Camtown soil and 25 to 40 percent Turton soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Camtown soil is dark gray loam about 10 inches thick. Below this is a mixed layer about 3 inches thick. This layer is grayish brown loam that has light brownish gray silt coatings on faces of peds. The subsoil is friable loam about 24 inches thick. The upper part is grayish brown and brown, and the lower part is light gray and calcareous. The underlying material to a depth of 60 inches is light gray, calcareous silt loam.

Typically, the surface layer of the Turton soil is dark gray loam about 7 inches thick. The subsurface layer also is dark gray loam. It is about 8 inches thick. The next layer is gray very fine sandy loam about 4 inches thick. The subsoil is friable loam about 28 inches thick. The upper part is grayish brown. The lower part is grayish brown and light brownish gray and is calcareous. It has crystals and nests of salt. The underlying material to a depth of 60 inches is light gray, calcareous very fine sandy loam that has crystals of salt.

Included with these soils in mapping are small areas of Camtown soils that are somewhat poorly drained and Egeland, Glyndon, and Tonka soils. These included soils make up less than 20 percent of this map unit. The somewhat poorly drained Camtown soils are on the slightly lower parts of the landscape. Egeland soils do not have a sodium-affected subsoil. They are on the slightly higher parts of the landscape. Glyndon soils have free lime at the surface. They are in positions on the landscape similar to those of the Turton soil. The poorly drained Tonka soils are in basins.

The content of organic matter is moderate in the Camtown and Turton soils, and fertility is medium. Both soils have a sodium-affected subsoil. Tilth is good in the Camtown soil and poor in the Turton soil. Permeability is moderately slow or slow in the subsoil of the Camtown soil and slow in the subsoil of the Turton soil. It is moderate to slow in the underlying material of both soils. Available water capacity is moderate or high in both soils. The water table is at a depth of 4 to 6 feet during wet periods. Runoff is slow. The shrink-swell potential is moderate in the subsoil and low in the underlying material.

Most areas are used as cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, crested wheatgrass, and pubescent wheatgrass. Wheat, corn, and barley are the main crops. The claypan subsoil in the Turton soil and the sodium in both soils restrict crop growth by limiting root penetration and the rate of water intake. Measures that improve tilth, increase the rate of water intake, and conserve moisture are the main management needs. Leaving crop residue on the surface, minimizing tillage, and including grasses and legumes in the cropping sequence are examples. Chiseling or subsoiling increases the rate of water intake and improves tilth.

If these soils are used for range, the claypan subsoil in the Turton soil limits productivity and the variety of suitable grasses. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings, but the sodium-affected subsoil is a limitation. Trees and shrubs can be established, but optimum survival, growth, and vigor are unlikely.

These soils are suited to most building site development, but the moderate shrink-swell potential and wetness are limitations. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Camtown soil is in capability unit IIIs-1, Clayey range site, and windbreak suitability group 4L; the Turton soil is in capability unit IVs-2, Claypan range site, and windbreak suitability group 9.

Cd—Cavour-Cresbard loams. These deep, moderately well drained, level and nearly level soils are on till plains. The Cavour soil is on foot slopes, and the Cresbard soil is on back slopes. Areas are irregular in shape and range from 25 to 300 acres in size. They are 55 to 65 percent Cavour soil and 20 to 30 percent Cresbard soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Cavour soil is dark gray loam about 8 inches thick. The subsurface layer is gray loam about 2 inches thick. The subsoil is about 17 inches thick. It is firm. The upper part is dark grayish brown clay. The lower part is grayish brown, calcareous clay loam that has nests of salt. The underlying material to a depth of 60 inches is light brownish gray and light gray, calcareous clay loam.

Typically, the surface layer of the Cresbard soil is dark gray loam about 7 inches thick. The subsurface layer is grayish brown loam about 3 inches thick. Below this is a transitional layer about 6 inches thick. This layer is grayish brown clay loam that has gray silt coatings on faces of peds. The subsoil is about 29 inches thick. It is firm. The upper part is grayish brown and light brownish gray silty clay. The lower part is light yellowish brown, calcareous clay loam. The underlying material to a depth of 60 inches also is light yellowish brown, calcareous clay loam.

Included with these soils in mapping are small areas of Ferney and Heil soils. These included soils make up less than 15 percent of this map unit. Ferney soils have visible salts within a depth of 16 inches. They are on the lower foot slopes. The poorly drained Heil soils are in basins.

The content of organic matter is moderate in the Cavour and Cresbard soils, and fertility is medium. Both soils have a sodium-affected subsoil. Tilth is poor in the Cavour soil and fair in the Cresbard soil. Permeability is slow or very slow in the subsoil of the Cavour soil and slow or moderately slow in the underlying material. It is moderately slow or slow in the Cresbard soil. Available water capacity is moderate in both soils. Runoff is slow. The shrink-swell potential is high in the subsoil and moderate in the underlying material.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, crested wheatgrass, and smooth brome. Wheat, barley, corn, and oats are the main crops. The dense claypan subsoil in the Cavour soil and the sodium in both soils restrict crop growth by limiting root penetration and the rate of water intake. Measures that increase the rate of water intake, improve tilth, and conserve moisture are the main management needs. Examples are leaving crop residue on the surface and including grasses and legumes in the cropping sequence. Chiseling or subsoiling increases the rate of water intake and improves tilth.

If these soils are used for range, the dense claypan subsoil in the Cavour soil limits productivity and the variety of suitable grasses. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth.

These soils are suited to windbreaks and environmental plantings, but the dense claypan subsoil in the Cavour soil is a limitation. Trees and shrubs can be established on this soil, but optimum survival, growth, and vigor are unlikely.

These soils are suited to most kinds of building site development, but the high shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Cavour soil is in capability unit IVs-2, Claypan range site, and windbreak suitability group 9; the Cresbard soil is in capability unit IIIs-1, Clayey range site, and windbreak suitability group 4L.

Cf—Cavour-Ferney complex. These deep, moderately well drained, level and nearly level soils are on till plains. The Cavour soil is on the lower back slopes and upper foot slopes, and the Ferney soil is on the lower foot slopes. Areas are irregular in shape and range from 5 to 200 acres in size. They are 45 to 55 percent Cavour soil and 30 to 40 percent Ferney soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Cavour soil is dark gray loam about 8 inches thick. The subsurface layer is gray loam about 2 inches thick. The subsoil is about 17 inches thick. It is firm. The upper part is dark grayish brown clay. The lower part is grayish brown, calcareous clay loam that has nests of salt. The underlying material to a depth of 60 inches is light brownish gray and light gray, calcareous clay loam.

Typically, the surface layer of the Ferney soil is dark gray clay loam about 5 inches thick. The subsoil is clay loam about 45 inches thick. The upper part is very dark grayish brown and very firm. The lower part is grayish brown and light yellowish brown, firm, and calcareous. It

has nests of salt. The underlying material to a depth of 60 inches is light yellowish brown, calcareous clay loam.

Included with these soils in mapping are small areas of Cresbard and Heil soils. These included soils make up less than 15 percent of this map unit. Cresbard soils do not have columnar structure in the subsoil. They are slightly higher on the landscape than the Cavour soil. The poorly drained Heil soils are in basins.

The content of organic matter is moderate in the Cavour and Ferney soils. Fertility is medium in the Cavour soil and low or medium in the Ferney soil. Both soils have a sodium-affected subsoil. Tilth is poor. Permeability is slow or very slow in the subsoil of the Cavour soil and moderately slow or slow in the underlying material. It is very slow in the Ferney soil. Available water capacity is moderate in both soils. Runoff is slow. The shrink-swell potential is high in the subsoil of the Cavour soil and moderate in the underlying material. It is high in the Ferney soil.

About half of the acreage is cropland. The Cavour soil is suited to cultivated crops and to tame pasture and hay. The dense claypan subsoil and the high content of sodium, however, restrict crop growth by limiting root penetration and the rate of water intake. No crops grow well on the Ferney soil. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and pubescent wheatgrass. Barley, wheat, and alfalfa are the main crops. Tilling is difficult because the dense subsoil is near the surface. If the soils are cultivated when wet, they become cloddy. Measures that conserve moisture, increase the rate of water intake, and improve tilth are the main management needs. Examples are tillage practices that leave crop residue on the surface, minimum tillage, and a cropping sequence that includes grasses and legumes. Chiseling and subsoiling increase the rate of water intake and improve tilth.

If these soils are used for range, the dense claypan subsoil limits productivity and the variety of suitable grasses. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth.

The Cavour soil is suited to windbreaks and environmental plantings, but the Ferney soil is generally unsuited. The sodium-affected subsoil is the main limitation. Trees and shrubs can be established on the Cavour soil, but optimum survival, growth, and vigor are unlikely. No trees or shrubs grow well on the Ferney soil.

These soils are suited to building site development, but the high shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. The absorption fields generally do not function well unless they are significantly enlarged.

The Cavour soil is in capability unit IVs-2, Claypan range site, and windbreak suitability group 9; the Ferney soil is in capability unit VIs-1, Thin Claypan range site, and windbreak suitability group 10.

Cm—Colvin fine sandy loam, saline. This deep, level, poorly drained soil is on glacial lake plains. Areas are irregular in shape and range from 5 to 200 acres in size. Slopes are smooth or slightly concave.

Typically, the surface layer is dark gray, calcareous fine sandy loam about 8 inches thick. It has nests of salt. The subsoil is about 19 inches thick. It is gray, friable, and calcareous. It has nests of salt. The upper part is fine sandy loam, and the lower part is silt loam. The underlying material to a depth of 60 inches is light gray, calcareous silt loam. In some places the soil contains less salt. In other places it contains less sand in the upper part.

Included with this soil in mapping are small areas of Stirum, Ulen, and Wyndmere soils. These soils make up less than 15 percent of this map unit. Stirum soils have a sodium-affected subsoil. They are in the slightly lower positions on the landscape. Ulen and Wyndmere soils contain more sand in the lower part than the Colvin soil. They are in positions on the landscape similar to those of the Colvin soil.

The content of organic matter is moderate in the Colvin soil, and fertility is low. Permeability is moderately rapid in the upper part of the profile and moderate to slow in the underlying material. Available water capacity is moderate or high. During wet periods the water table is within a depth of 2 feet. Runoff is slow. The shrink-swell potential is low in the upper part of the profile and moderate in the lower part.

Most of the acreage supports native grasses and is used for grazing. The high content of salts reduces the vigor of all species that are not tolerant of salt. Wind erosion is a hazard unless an adequate plant cover is maintained. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity and an adequate plant cover.

This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are tall wheatgrass and western wheatgrass. The main crops are barley, wheat, and oats. Wetness delays tillage in the spring of most years. A high content of

lime and salts in the surface layer restricts the availability of plant nutrients. Measures that reduce wetness, control wind erosion, and improve fertility are the main management needs. Minimizing tillage, leaving crop residue on the surface, and including grasses and legumes in the cropping sequence help to control wind erosion and improve fertility.

This soil is generally unsuited to windbreaks and environmental plantings, building site development, and septic tank absorption fields because of the wetness and the excess salts.

This soil is in capability unit IVw-4, Saline Subirrigated range site, and windbreak suitability group 10.

Cn—Colvin silty clay loam. This deep, level, poorly drained and very poorly drained soil is on glacial lake plains. It is subject to rare flooding. Areas are irregular in shape and range from 5 to 100 acres in size. Slopes are smooth or slightly concave.

Typically, the surface layer is dark gray, calcareous silty clay loam about 8 inches thick. The subsoil is light gray, friable, calcareous silt loam about 11 inches thick. The underlying material to a depth of 60 inches is light gray and pale olive, calcareous silty clay loam and silt loam. It has distinct mottles.

Included with this soil in mapping are small areas of Bearden and Beotia soils. These soils make up less than 15 percent of this map unit. The somewhat poorly drained Bearden soils are on the slightly higher parts of the landscape. The well drained Beotia soils are on the upper foot slopes. Also included are saline spots as much as 3 acres in size.

The content of organic matter is high in the Colvin soil, and fertility is medium. Permeability is moderate to slow. Available water capacity is high. During wet periods the water table is within a depth of 1 foot. Runoff is very slow. The shrink-swell potential is moderate.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, Garrison creeping foxtail, reed canarygrass, intermediate wheatgrass, and smooth brome. Wheat, corn, barley, and alfalfa are the main crops. Wetness and a high content of lime in the surface layer are limitations. The high content of lime restricts the availability of plant nutrients. Measures that maintain fertility and reduce wetness are the main management needs. Leaving crop residue on the surface, minimizing tillage, and including grasses and legumes in the cropping sequence help to maintain fertility. Diverting runoff from the adjacent soils reduces the wetness. Surface drains also help to remove excess water.

If this soil is used for range, compaction can be a problem. Deferring grazing during wet periods helps to prevent compaction and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is generally unsuited to windbreaks and environmental plantings, building site development, and septic tank absorption fields because of the wetness.

This soil is in capability unit IVw-3, Subirrigated range site, and windbreak suitability group 10.

Cp—Colvin silty clay loam, ponded. This deep, very poorly drained, level soil is on glacial lake plains. It is subject to rare flooding and is ponded after periods of heavy rainfall or snowmelt. Areas are circular or oblong and range from 5 to 80 acres in size. Slopes are smooth or concave.

Typically, the surface layer is dark gray, calcareous silty clay loam about 8 inches thick. The subsoil is light gray, friable, calcareous silt loam about 11 inches thick. The underlying material to a depth of 60 inches is light gray and pale olive, calcareous silty clay loam and silt loam. It has distinct mottles. In some areas the soil is better drained. In other areas it has visible salts throughout. In places it contains more very fine sand and less clay.

Included with this soil in mapping are small areas of the somewhat poorly drained Bearden and Wyndmere soils. These soils make up less than 15 percent of this map unit. They are in the slightly higher positions on the landscape, around the edges of the mapped areas. Wyndmere soils contain more sand and less clay than the Colvin soil.

The content of organic matter is high in the Colvin soil, and fertility is medium. Available water capacity is high. Permeability is moderate to slow. During wet periods the water table is within a depth of 1 foot. As much as 1 foot of water may pond on this soil. Runoff is ponded. The shrink-swell potential is moderate.

Most of the acreage supports native grasses and is used for grazing or for hay. The ponding is a hazard. Deferring grazing during wet periods helps to prevent compaction of the surface layer and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum production.

Some areas are cultivated along with the adjacent areas. This soil is generally unsuited to cultivated crops because of the ponding, which frequently delays planting and harvesting for long periods.

This soil is suited to tame pasture and hay, but the ponding limits the choice of plants. Only water-tolerant species, such as reed canarygrass and Garrison

creeping foxtail, are suitable. Artificial drainage generally is not feasible.

This soil is generally unsuited to windbreaks and environmental plantings, building site development, and septic tank absorption fields because of the ponding.

This soil is in capability unit Vw-1, Wetland range site, and windbreak suitability group 10.

Cs—Colvin silty clay loam, saline. This deep, very poorly drained, level, saline soil is on glacial lake plains. It is frequently flooded after periods of heavy rainfall or snowmelt. Areas are irregular in shape and range from 5 to 200 acres in size. Slopes are smooth or slightly concave.

Typically, the surface layer is dark gray, calcareous silty clay loam about 7 inches thick. The subsoil is friable, calcareous silty clay loam about 17 inches thick. It is dark gray and light brownish gray in the upper part and light gray in the lower part. The underlying material to a depth of 60 inches is light gray, calcareous silty clay loam. The soil has nests of salt throughout.

Included with this soil in mapping are small areas of the somewhat poorly drained Bearden soils. These soils make up less than 15 percent of this map unit. They are in the slightly higher positions on the landscape, adjacent to basins.

The content of organic matter is high in the Colvin soil, and fertility is low. Permeability is moderate to slow. Available water capacity is moderate. During wet periods the water table is within a depth of 2 feet. Runoff is very slow. The shrink-swell potential is moderate.

Most of the acreage supports native grasses and is used for grazing. The frequent flooding and the high content of salts limit productivity and the variety of suitable grasses. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum production.

This soil is suited to tame pasture and hay, but the high content of salts and the frequent flooding are limitations. Examples of suitable pasture plants are tall wheatgrass, switchgrass, and western wheatgrass. Deferring grazing during wet periods helps to prevent compaction of the surface layer.

This soil is generally unsuited to cultivated crops, windbreaks and environmental plantings, building site development, and septic tank absorption fields because of the wetness and the high content of salts.

This soil is in capability unit IVw-4, Saline Subirrigated range site, and windbreak suitability group 10.

Cv—Cresbard-Cavour loams. These deep, moderately well drained, level and nearly level soils are on moraines. The Cresbard soil is on the lower back slopes, and the Cavour soil is on the upper foot slopes. Areas are irregular in shape and range from 25 to 300 acres in size. They are 45 to 55 percent Cresbard soil and 35 to 45 percent Cavour soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Cresbard soil is dark gray loam about 7 inches thick. The subsurface layer is grayish brown loam about 3 inches thick. Below this is a transitional layer about 6 inches thick. This layer is grayish brown clay loam that has gray silt coatings on faces of peds. The subsoil is about 29 inches thick. It is firm. The upper part is grayish brown and light brownish gray silty clay. The lower part is light yellowish brown, calcareous clay loam. The underlying material to a depth of 60 inches also is light yellowish brown, calcareous clay loam.

Typically, the surface layer of the Cavour soil is dark gray loam about 8 inches thick. The subsurface layer is gray loam about 2 inches thick. The subsoil is about 17 inches thick. It is firm. The upper part is dark grayish brown clay. The lower part is grayish brown, calcareous clay loam that has nests of salt. The underlying material to a depth of 60 inches is light brownish gray and light gray, calcareous clay loam.

Included with these soils in mapping are small areas of Ferney and Heil soils. These included soils make up less than 15 percent of this map unit. Ferney soils have visible salts within a depth of 16 inches. They are on the lower foot slopes. The poorly drained Heil soils are in basins.

The content of organic matter is moderate in the Cresbard and Cavour soils, and fertility is medium. Both soils have a sodium-affected subsoil. Tilth is fair in the Cresbard soil and poor in the Cavour soil. Permeability is moderately slow or slow in the Cresbard soil. It is slow or very slow in the subsoil of the Cavour soil and slow or moderately slow in the underlying material. Available water capacity is moderate in both soils. Runoff is slow. The shrink-swell potential is high in the subsoil and moderate in the underlying material.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, crested wheatgrass, and smooth brome. Wheat, barley, corn, and oats are the main crops. The dense claypan subsoil in the Cavour soil and the sodium in both soils restrict crop growth by limiting root penetration and the rate of water intake. Measures that increase the rate of water intake, improve tilth, and conserve moisture are the main management needs. Examples are leaving crop residue on the surface and including grasses and legumes in

the cropping sequence. Chiseling and subsoiling increase the rate of water intake and improve tilth.

If these soils are used for range, the dense claypan subsoil in the Cavour soil limits productivity and the variety of suitable grasses. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth.

These soils are suited to windbreaks and environmental plantings, but the dense claypan subsoil in the Cavour soil is a limitation. Trees and shrubs can be established on this soil, but optimum survival, growth, and vigor are unlikely.

These soils are suited to most kinds of building site development, but the high shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Cresbard soil is in capability unit IIIs-1, Clayey range site, and windbreak suitability group 4L; the Cavour soil is in capability unit IVs-2, Claypan range site, and windbreak suitability group 9.

DaA—Daglum-Rhoades loams, 0 to 4 percent slopes. These deep, moderately well drained, level and gently sloping soils are on terraces. The Daglum soil is on the upper foot slopes, and the Rhoades soil is on the lower foot slopes. In places scattered stones are on the surface. Areas are irregular in shape and range from 5 to 300 acres in size. They are 45 to 55 percent Daglum soil and 30 to 40 percent Rhoades soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Daglum soil is dark grayish brown loam about 6 inches thick. The subsurface layer is light brownish gray loam about 3 inches thick. The subsoil is about 33 inches thick. It is firm. The upper part is dark grayish brown clay loam. The next part is grayish brown, calcareous clay loam that has nests of salt. The lower part is light brownish gray, calcareous silty clay. Gray, calcareous shale is at a depth of about 42 inches. In some places the soil does not have shale within a depth of 42 inches. In other places the subsoil has more sand and less clay.

Typically, the surface layer of the Rhoades soil is light brownish gray loam about 2 inches thick. The subsoil is firm clay loam about 32 inches thick. The upper part is grayish brown. The next part is light brownish gray and has crystals of salt. The lower part is light brownish gray and is calcareous. It has nests of salt. The underlying material extends to a depth of about 46 inches. It is light olive gray, calcareous clay loam that has nests of salt. Below this to a depth of 60 inches is light olive gray, bedded shale. In some places the underlying material does not have shale. In other places the subsoil has more sand and less clay.

Included with these soils in mapping are small areas of Brantford Variant, Edgeley, and Kloten soils. These included soils make up less than 15 percent of this map unit. The well drained Brantford Variant, Edgeley, and Kloten soils do not have a sodium-affected subsoil. They are slightly higher on the landscape than the Daglum soil.

The content of organic matter is moderate in the Daglum and Rhoades soils. Fertility is medium in the Daglum soil and low in the Rhoades soil. Both soils have a sodium-affected subsoil. Tilth is poor. Permeability is very slow in both soils, and available water capacity is low. Runoff is slow or medium. The shrink-swell potential is high.

Most of the acreage supports native grasses and is used for grazing. The dense, compact subsoil limits productivity and the variety of suitable grasses. Surface compaction is a major problem on the Rhoades soil. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are poorly suited to cultivated crops and to tame pasture and hay. Crop growth is severely restricted on the Daglum soil because of the dense, sodium-affected subsoil. No crops grow well on the Rhoades soil. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, crested wheatgrass, and pubescent wheatgrass. Measures that improve tilth, increase the rate of water intake, and conserve moisture are the main management needs. Examples are leaving crop residue on the surface, applying animal manure, and including grasses and legumes in the cropping sequence. Chiseling and subsoiling improve tilth and increase the rate of water intake.

The Daglum soil is suited to windbreaks and environmental plantings, but the Rhoades soil is generally unsuited. The dense, sodium-affected subsoil in both soils is a limitation. Trees and shrubs can be established on the Daglum soil, but optimum growth, survival, and vigor are unlikely. No trees or shrubs grow well on the Rhoades soil.

These soils are suited to building site development, but the high shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation

drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the footings and foundations also helps to prevent this damage.

These soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. The absorption fields generally do not function well unless they are significantly enlarged.

The Daglum soil is in capability unit IVs-3, Claypan range site, and windbreak suitability group 9; the Rhoades soil is in capability unit VIs-1, Thin Claypan range site, and windbreak suitability group 10.

Do—Dovray silty clay. This deep, poorly drained and very poorly drained, level, clayey soil is on flood plains and glacial lake plains. It is ponded during periods of snowmelt and after heavy rains in basins on the glacial lake plains and for long periods on the flood plains. Areas are long and narrow, oval, or irregularly shaped and range from 5 to 100 acres in size. Slopes are concave.

Typically, the surface layer is dark gray silty clay about 6 inches thick. The subsurface layer also is dark gray silty clay. It is about 10 inches thick. The subsoil is firm silty clay about 24 inches thick. The upper part is gray, and the lower part is gray and light gray and is calcareous. The underlying material to a depth of 60 inches is light gray, calcareous silty clay loam. In places free carbonates are at the surface.

Included with this soil in mapping are small areas of Colvin, Lamoure, and Playmoor soils. These soils make up less than 10 percent of this map unit. They contain more silt and less clay than the Dovray soil and have free carbonates at the surface. The poorly drained Colvin soils are on toe slopes. The somewhat poorly drained Lamoure and poorly drained Playmoor soils are slightly higher on the flood plains than the Dovray soil.

The content of organic matter is high in the Dovray soil. Fertility also is high. Tilth is poor. Permeability is slow or very slow. Available water capacity is moderate or high. A seasonal high water table is within a depth of 1 foot. As much as 2 feet of water ponds on the surface during some wet periods. Runoff is ponded. The shrink-swell potential is high.

About half of the acreage supports native grasses and is used for grazing. Wetness limits productivity and the variety of suitable pasture plants, and surface compaction is a major limitation. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain productivity.

This soil is suited to tame pasture and hay, but the ponding is a hazard. The choice of suitable tame pasture plants is limited to water-tolerant species, such as Garrison creeping foxtail and reed canarygrass.

This soil is generally unsuited to cultivated crops, windbreaks and environmental plantings, building site development, and septic tank absorption fields because of the wetness and the ponding.

This soil is in capability unit Vw-4, Wetland range site, and windbreak suitability group 10.

Dv—Dovray Variant silty clay. This deep, somewhat poorly drained, level, clayey soil is on flood plains. It is subject to rare flooding. Areas are irregular in shape and range from 10 to more than 200 acres in size. Slopes are smooth or slightly concave.

Typically, the surface layer is dark gray silty clay about 7 inches thick. The subsoil is firm silty clay about 43 inches thick. The upper part is dark gray, the next part is gray, and the lower part is gray and calcareous. The upper part of the underlying material is olive gray, calcareous clay loam. The lower part to a depth of 60 inches is light olive gray, calcareous sandy clay loam.

Included with this soil in mapping are small areas of Harmony Variant, Ludden, and Ryan soils. These soils make up less than 10 percent of this map unit. The moderately well drained Harmony Variant soils have a sandy substratum. They are slightly higher on the landscape than the Dovray Variant soil. Ludden and Ryan soils are slightly lower on the landscape than the Dovray Variant soil. Ludden soils have free carbonates at the surface. Ryan soils have a sodium-affected subsoil.

The content of organic matter is high in the Dovray Variant soil. Fertility also is high. Tilth is fair. Permeability is slow or very slow. Available water capacity is moderate or high. A seasonal high water table is at a depth of 4 to 6 feet. Runoff is slow. The shrink-swell potential is high.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Corn, wheat, barley, and alfalfa are the main crops. Fieldwork is delayed in some years because of wetness. Planting late-season crops may be helpful. Measures that improve tilth are the main management needs. Chiseling or subsoiling, timely tillage, tillage practices that leave crop residue on the surface, and a cropping sequence that includes grasses and legumes are examples.

If this soil is used for range, compaction is a problem. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, and those that require an abundant supply of moisture grow especially well.

This soil is generally unsuited to building site development and septic tank absorption fields because of the flooding and the restricted permeability. Sites that are better suited generally are available on the adjacent uplands.

This soil is in capability unit IIw-2, Overflow range site, and windbreak suitability group 2W.

EcA—Eckman very fine sandy loam, 0 to 2 percent slopes. This deep, well drained, level and nearly level soil is on glacial lake plains. Areas are irregular in shape and range from 20 to 300 acres in size. Slopes are long and smooth.

Typically, the surface layer is dark grayish brown very fine sandy loam about 12 inches thick. The subsoil is about 32 inches thick. It is very friable. The upper part is grayish brown very fine sandy loam. The lower part is light brownish gray, calcareous silt loam. The underlying material to a depth of 60 inches is light gray, calcareous very fine sandy loam. In places the soil is dark to a depth of more than 16 inches.

Included with this soil in mapping are small areas of Embden, Glyndon, and Swenoda soils. These soils make up less than 15 percent of this map unit. Embden soils have more sand than the Eckman soil. They are in the slightly lower concave areas. Glyndon soils have carbonates throughout. They are on toe slopes. Swenoda soils contain more sand in the upper part than the Eckman soil and have silty material within a depth of 40 inches. They are in positions on the landscape similar to those of the Eckman soil.

The content of organic matter is moderate in the Eckman soil, and fertility is medium or high. Permeability is moderate, and available water capacity is high. Runoff is slow.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, switchgrass, and smooth brome. Wheat, corn, soybeans, and oats are the main crops. Conserving moisture and controlling wind erosion are the main management needs. Tillage practices that leave crop residue on the surface, stripcropping, and field windbreaks are examples.

No major hazards or limitations affect the use of this soil for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to windbreaks and environmental plantings. Except for the species that require an abundant supply of moisture, all climatically suited trees and shrubs grow well.

This soil is suited to building site development and septic tank absorption fields.

This soil is in capability unit IIe-6, Silty range site, and windbreak suitability group 3.

EdB—Eckman-Gardena very fine sandy loams, 2 to 6 percent slopes. These deep, very gently sloping and gently sloping soils are on glacial lake plains. The well drained Eckman soil is on back slopes, and the well drained and moderately well drained Gardena soil is on foot slopes. Areas are irregular in shape and range from 20 to 200 acres in size. They are 50 to 70 percent Eckman soil and 30 to 45 percent Gardena soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Eckman soil is dark grayish brown very fine sandy loam about 12 inches thick. The subsoil is about 32 inches thick. It is very friable. The upper part is grayish brown very fine sandy loam. The lower part is light brownish gray, calcareous silt loam. The underlying material to a depth of 60 inches is light gray, calcareous very fine sandy loam.

Typically, the surface layer of the Gardena soil is dark gray very fine sandy loam about 8 inches thick. The subsurface layer also is dark gray very fine sandy loam. It is about 12 inches thick. The subsoil is grayish brown and light gray, friable silt loam about 24 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light gray, calcareous silt loam.

Included with these soils in mapping are small areas of Glyndon and Zell soils. These included soils make up less than 15 percent of this map unit. They have free lime at or near the surface. The moderately well drained and somewhat poorly drained Glyndon soils are on the lower toe slopes. The well drained Zell soils are on shoulder slopes.

The content of organic matter is moderate in the Eckman soil and high in the Gardena soil. Fertility is medium or high in the Eckman soil and high in the Gardena soil. Permeability is moderate in both soils. Available water capacity is high. The Gardena soil has a water table at a depth of 4 to 6 feet during wet periods. Runoff is slow or medium on the Eckman soil and slow on the Gardena soil.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, switchgrass, and smooth brome. Wheat, corn, soybeans, and oats are the main crops. Measures that control erosion and conserve moisture are the main management needs. Examples

are tillage practices that leave crop residue on the surface, contour farming, and terraces. Grassed waterways help to keep gullies from forming. In some areas the slopes are too short and irregular for contouring and terracing.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Eckman soil, except for those that require an abundant supply of moisture. Species that require an abundant supply of moisture grow especially well on the Gardena soil. Planting on the contour helps to control erosion.

The Eckman soil is suited to building site development and septic tank absorption fields. The Gardena soil also is suited, but wetness is a limitation. Installing foundation drains and diverting water away from the buildings help to overcome this limitation. Septic tank absorption fields should be installed in areas of the Eckman soil rather than in areas of the Gardena soil.

The Eckman soil is in capability unit IIe-1, Silty range site, and windbreak suitability group 3; the Gardena soil is in capability unit IIe-6, Silty range site, and windbreak suitability group 1.

EeB—Eckman-Zell very fine sandy loams, 1 to 6 percent slopes. These deep, well drained, very gently sloping and gently sloping soils are on glacial lake plains. The Eckman soil is on back slopes, and the Zell soil is on shoulder slopes and summits. Areas are elongated or irregularly shaped and range from 5 to 80 acres in size. They are 60 to 70 percent Eckman soil and 20 to 30 percent Zell soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Eckman soil is dark grayish brown very fine sandy loam about 12 inches thick. The subsoil is about 32 inches thick. It is very friable. The upper part is grayish brown very fine sandy loam. The lower part is light brownish gray, calcareous silt loam. The underlying material to a depth of 60 inches is light gray, calcareous very fine sandy loam. In places the soil is dark to a depth of more than 16 inches.

Typically, the surface layer of the Zell soil is dark gray, calcareous very fine sandy loam about 6 inches thick. Below this is a mixed layer of grayish brown, calcareous silt loam about 5 inches thick. The subsoil is light brownish gray, friable, calcareous silt loam about 7 inches thick. The underlying material to a depth of 60 inches is light gray and pale yellow, calcareous silt loam.

Included with these soils in mapping are small areas of the moderately well drained and somewhat poorly drained Glyndon soils. These included soils make up less than 15 percent of this map unit. They have free lime throughout. They are on toe slopes.

The content of organic matter is moderate in the Eckman and Zell soils. Fertility is medium or high in the Eckman soil and low or medium in the Zell soil. Permeability is moderate in both soils. Available water capacity is high. Runoff is slow or medium on the Eckman soil and medium on the Zell soil.

Most of the acreage is cultivated. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, and oats are the main crops. A high content of lime in the surface layer of the Zell soil restricts the availability of plant nutrients. Controlling wind erosion, conserving moisture, and maintaining fertility are the main management needs. Minimizing tillage and leaving crop residue on the surface help to control wind erosion, conserve moisture, and improve fertility. Where the slopes are suitable, contour farming, terraces, and grassed waterways help to control water erosion.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

The Eckman soil is suited to windbreaks and environmental plantings. Except for the species that require an abundant supply of moisture, all climatically suited trees and shrubs grow well. The Zell soil is suited to windbreaks and environmental plantings, but the high content of lime in the surface layer limits the available water capacity and the availability of plant nutrients. Selected trees and shrubs can be established on this soil, but optimum survival, growth, and vigor are unlikely. Planting on the contour helps to control water erosion.

These soils are suited to building site development and septic tank absorption fields.

The Eckman soil is in capability unit IIe-1, Silty range site, and windbreak suitability group 3; the Zell soil is in capability unit IVe-2, Thin Upland range site, and windbreak suitability group 8.

EgB—Edgeley-Kloten complex, 1 to 6 percent slopes. These very gently sloping and gently sloping, well drained soils are on dissected plains. The moderately deep Edgeley soil is on back slopes, and the shallow Kloten soil is on shoulder slopes. The Kloten soil generally has scattered stones on the

surface. In places the stones cover 3 to 10 percent of the surface. Areas of this map unit are irregular in shape and range from 5 to 80 acres in size. They are 45 to 55 percent Edgeley soil and 30 to 40 percent Kloten soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Edgeley soil is dark grayish brown loam about 7 inches thick. The subsoil is friable clay loam about 17 inches thick. It is grayish brown in the upper part and light brownish gray in the lower part. Below this to a depth of 60 inches is light gray, bedded shale.

Typically, the surface layer of the Kloten soil is dark gray clay loam about 6 inches thick. The underlying material extends to a depth of about 18 inches. It is light brownish gray and gray clay loam. It is calcareous in the lower part. Below this to a depth of 60 inches is gray, hard, bedded shale.

Included with these soils in mapping are small areas of Vida, Williams, and Zahl soils. These included soils make up less than 15 percent of this map unit. They do not have bedded shale within a depth of 40 inches. They are on summits.

The content of organic matter is moderate in the Edgeley soil and low to moderate in the Kloten soil. Fertility is medium in the Edgeley soil and low or medium in the Kloten soil. Permeability is moderate above the bedded shale in both soils. Available water capacity is low or moderate in the Edgeley soil and low in the Kloten soil. Runoff is medium on both soils. The shrink-swell potential is moderate above the bedded shale.

Most areas support native range and are used for grazing. No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

The Edgeley soil is suited to cultivated crops and to tame pasture and hay. Alfalfa, intermediate wheatgrass, and smooth brome are suitable pasture plants. The Kloten soil is generally unsuited to cultivated crops because of the shallowness to bedded shale. Controlling erosion and conserving moisture are the main management needs. Minimum tillage and tillage practices that leave crop residue on the surface help to control erosion, conserve moisture, and improve fertility. In some areas the surface stones hinder the use of farm machinery.

The Edgeley soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, except for those that require an abundant supply of moisture. The Kloten soil is generally unsuited to windbreaks and environmental plantings because of the shallowness to bedded shale.

The Edgeley soil is suited to building site development, but the depth to bedded shale and the moderate shrink-swell potential are limitations. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. The Kloten soil is unsuited to building site development because of the shallowness to bedded shale.

These soils are unsuited to septic tank absorption fields because of the bedded shale within a depth of 40 inches.

The Edgeley soil is in capability unit IIe-1, Silty range site, and windbreak suitability group 6R; the Kloten soil is in capability unit VIe-11, Shallow range site, and windbreak suitability group 10.

EhA—Egeland fine sandy loam, 0 to 2 percent slopes. This deep, level and nearly level, well drained soil is on glacial lake plains. Areas are irregular in shape and range from 10 to 200 acres in size. Slopes are smooth.

Typically, the surface layer is dark gray fine sandy loam about 8 inches thick. The subsoil is about 30 inches thick. It is very friable. The upper part is grayish brown and light brownish gray fine sandy loam. The lower part is light brownish gray, calcareous loamy very fine sand. The underlying material to a depth of 60 inches is light gray, calcareous loamy very fine sand. In places the dark surface layer is more than 16 inches thick.

Included with this soil in mapping are small areas of Swenoda and Tiffany soils. These soils make up less than 10 percent of this map unit. The moderately well drained Swenoda soils are on foot slopes. They have silty lacustrine material within a depth of 40 inches. The poorly drained or somewhat poorly drained Tiffany soils are in basins.

The content of organic matter is moderate in the Egeland soil, and fertility is medium. Permeability is moderately rapid. Available water capacity is low or moderate. Runoff is slow. The shrink-swell potential is low.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, and oats are the main crops. The main management needs are measures that control wind erosion, conserve moisture, and maintain fertility. Tillage practices that leave crop residue on the surface, field windbreaks, stripcropping, and a cropping

sequence that includes grasses and legumes are examples. A mulch of crop residue helps to control wind erosion until pasture plants are established.

If this soil is used for range, wind erosion can be a problem unless an adequate plant cover is maintained. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain productivity and an adequate plant cover.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well. Planting after minimal site preparation helps to control wind erosion.

This soil is suited to building site development, but the sides of shallow excavations tend to cave in unless they are shored. The soil is suited to septic tank absorption fields.

This soil is in capability unit IIIe-7, Sandy range site, and windbreak suitability group 5.

EkB—Egeland-Embden fine sandy loams, 2 to 6 percent slopes. These deep, gently sloping soils are on outwash plains and glacial lake plains. The well drained Egeland soil is on back slopes, and the well drained and moderately well drained Embden soil is on the lower back slopes and foot slopes. Areas are long and narrow or irregularly shaped and range from 10 to 350 acres in size. They are 45 to 55 percent Egeland soil and 30 to 40 percent Embden soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Egeland soil is dark gray fine sandy loam about 8 inches thick. The subsoil is about 30 inches thick. It is very friable. The upper part is grayish brown and light brownish gray fine sandy loam. The lower part is light brownish gray, calcareous loamy very fine sand. The underlying material to a depth of 60 inches is light gray, calcareous loamy very fine sand.

Typically, the surface layer of the Embden soil is dark gray fine sandy loam about 7 inches thick. The subsurface layer also is dark gray fine sandy loam. It is about 9 inches thick. The subsoil is grayish brown and light gray, very friable fine sandy loam about 27 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light gray, calcareous very fine sandy loam. In places silty lacustrine material is within a depth of 40 inches.

Included with these soils in mapping are small areas of Eckman, Gardena, Tiffany, and Wyndmere soils. These included soils make up less than 15 percent of this map unit. Eckman and Gardena soils have less sand and more silt than the major soils. Eckman soils are in positions on the landscape similar to those of the Egeland soil. Gardena soils are intermingled with areas of the Embden soil. The poorly drained or somewhat poorly drained Tiffany soils are in basins. Wyndmere soils have free carbonates within a depth of 16 inches. They are on toe slopes between and around basins.

The content of organic matter is moderate in the Egeland and Embden soils, and fertility is medium. Permeability is moderately rapid. Available water capacity is low or moderate in the Egeland soil. It is moderate in the Embden soil. The Embden soil has a water table at a depth of 4 to 6 feet during wet periods. Runoff is slow on both soils. The shrink-swell potential is low.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, and oats are the main crops. The main management needs are measures that control wind erosion and maintain fertility in areas of both soils and measures that conserve moisture in areas of the Egeland soil. Examples are tillage practices that leave crop residue on the surface, field windbreaks, stripcropping, and a cropping sequence that includes grasses and legumes. A mulch of crop residue helps to control wind erosion until pasture plants are established.

If these soils are used for range, wind erosion can be a problem unless an adequate plant cover is maintained. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain productivity and an adequate plant cover.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well. Those that require an abundant supply of moisture grow especially well on the Embden soil. Planting after minimal site preparation helps to control wind erosion.

These soils are suited to building site development, but the sides of shallow excavations tend to cave in unless they are shored. Wetness also is a limitation in the Embden soil. Installing foundation drains and diverting runoff away from the buildings help to overcome the wetness.

These soils are suited to septic tank absorption fields, but the seasonal high water table is a limitation in the Embden soil.

The Egeland soil is in capability unit IIIe-8, Sandy range site, and windbreak suitability group 5; the Embden soil is in capability unit IIIe-8, Sandy range site, and windbreak suitability group 1.

Em—Embden fine sandy loam. This deep, level and nearly level, well drained and moderately well drained soil is on glacial lake plains. Areas are irregular in

shape and range from 10 to 250 acres in size. Slopes are smooth or slightly concave.

Typically, the surface layer of the Embden soil is dark gray fine sandy loam about 7 inches thick. The subsurface layer also is dark gray fine sandy loam. It is about 9 inches thick. The subsoil is very friable fine sandy loam about 27 inches thick. The upper part is grayish brown, and the lower part is light gray and is calcareous. The underlying material to a depth of 60 inches is light gray, calcareous very fine sandy loam. In some places silty lacustrine material is within a depth of 40 inches. In other places the soil is dark to a depth of less than 16 inches.

Included with this soil in mapping are small areas of Tiffany and Wyndmere soils. These soils make up less than 10 percent of this map unit. The poorly drained and somewhat poorly drained Tiffany soils are in basins. Wyndmere soils have free lime within a depth of 16 inches. They are on the lower slopes between and around the basins.

The content of organic matter is moderate in the Embden soil, and fertility is medium. Permeability is moderately rapid. Available water capacity is moderate. The water table is at a depth of 4 to 6 feet during wet periods. Runoff is slow. The shrink-swell potential is low.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, and oats are the main crops. The main management needs are measures that control wind erosion and maintain fertility. Examples are tillage practices that leave crop residue on the surface, field windbreaks, stripcropping, and a cropping sequence that includes grasses and legumes.

If this soil is used for range, wind erosion can be a problem unless an adequate plant cover is maintained. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain productivity and an adequate plant cover.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, and those that require an abundant supply of moisture grow especially well. Planting after minimal site preparation helps to control wind erosion.

This soil is suited to building site development, but the wetness is a limitation. Also, the sides of shallow excavations tend to cave in unless they are shored. Installing foundation drains and diverting runoff away from the buildings help to prevent the structural damage caused by wetness.

This soil is suited to septic tank absorption fields, but the seasonal high water table is a limitation.

This soil is in capability unit IIIe-7, Sandy range site, and windbreak suitability group 1.

Et—Embden-Tiffany fine sandy loams. These deep, level to very gently sloping soils are on glacial lake plains. Slopes are 0 to 3 percent. The well drained and moderately well drained Embden soil is on foot slopes, and the somewhat poorly drained and poorly drained Tiffany soil is in basins. The Tiffany soil is ponded for short periods. Areas are irregular in shape and range from 20 to 300 acres in size. They are 60 to 75 percent Embden soil and 20 to 35 percent Tiffany soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Embden soil is dark gray fine sandy loam about 7 inches thick. The subsurface layer also is dark gray fine sandy loam. It is about 9 inches thick. The subsoil is very friable fine sandy loam about 27 inches thick. The upper part is grayish brown, and the lower part is light gray and is calcareous. The underlying material to a depth of 60 inches is light gray, calcareous very fine sandy loam. In some places the soil is dark to a depth of less than 16 inches. In other places silty lacustrine material is within a depth of 40 inches.

Typically, the surface layer of the Tiffany soil is dark gray fine sandy loam about 7 inches thick. The subsurface layer also is dark gray fine sandy loam. It is about 5 inches thick. The next layer also is dark gray fine sandy loam. It is about 11 inches thick. The underlying material to a depth of 60 inches is light brownish gray and light olive gray loamy very fine sand.

Included with these soils in mapping are small areas of Eckman, Gardena, Glyndon, and Wyndmere soils. These included soils make up less than 20 percent of this map unit. Eckman, Gardena, and Glyndon soils contain more silt and less fine sand than the Embden and Tiffany soils. Eckman soils are on back slopes. Gardena soils are in positions on the landscape similar to those of the Embden soil. Glyndon and Wyndmere soils have lime at the surface. They are on the lower toe slopes around the edges of the mapped areas.

The content of organic matter is moderate in the Embden soil and high in the Tiffany soil. Fertility is medium in the Embden soil and high in the Tiffany soil. Permeability is moderately rapid in the Embden soil and moderate in the Tiffany soil. During wet periods, the Embden soil has a seasonal high water table at a depth of 4 to 6 feet and the Tiffany soil has one within a depth of 3 feet. As much as 1 foot of water ponds on the Tiffany soil during wet periods. Runoff is slow on the Embden soil and very slow or ponded on the Tiffany soil. The shrink-swell potential is low in both soils.

Most of the acreage is cropland. These soils are

suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Reed canarygrass and Garrison creeping foxtail also are suitable on the Tiffany soil. Wheat, corn, and oats are the main crops. Measures that control wind erosion and maintain fertility in areas of both soils and that reduce wetness in areas of the Tiffany soil are the main management needs. Tillage practices that leave crop residue on the surface, minimum tillage, a cropping sequence that includes grasses and legumes, stripcropping, and field windbreaks help to control wind erosion and maintain fertility. In most years planting and harvesting are delayed on the Tiffany soil because of the wetness and the ponding.

If these soils are used for range, wind erosion can be a problem unless an adequate plant cover is maintained. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain productivity and an adequate plant cover.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, and those that require an abundant supply of moisture grow especially well.

The Embden soil is suited to building site development, but the wetness is a limitation. Also, the sides of shallow excavations tend to cave in unless they are shored. Installing foundation drains and diverting runoff away from the buildings help to prevent the structural damage caused by wetness. The Embden soil is suited to septic tank absorption fields, but the seasonal high water table is a limitation.

The Tiffany soil is generally unsuited to building site development and septic tank absorption fields because of the ponding.

The Embden soil is in capability unit IIIe-7, Sandy range site, and windbreak suitability group 1; the Tiffany soil is in capability unit IIIw-5, Subirrigated range site, and windbreak suitability group 2S.

Ex—Exline-Aberdeen-Nahon silt loams. These deep, level and nearly level soils are on glacial lake plains. The somewhat poorly drained Exline soil is on the lower foot slopes. The moderately well drained Aberdeen soil and the somewhat poorly drained and moderately well drained Nahon soil are on the upper foot slopes and the lower back slopes. Areas are irregular in shape and range from 10 to more than 200 acres in size. They are 35 to 45 percent Exline soil, 15 to 35 percent Aberdeen soil, and 15 to 35 percent Nahon soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Exline soil is dark gray silt loam about 2 inches thick. The subsurface layer is gray silt loam about 1 inch thick. The subsoil is about 31 inches thick. It is calcareous in the lower 23 inches. The upper part is dark gray very firm clay. The next part is dark gray, gray, and light brownish gray very firm clay that has nests of salt. The lower part is light brownish gray, firm silty clay loam. The underlying material to a depth of 60 inches is light gray, calcareous silty clay loam that is varved.

Typically, the surface layer of the Aberdeen soil is dark gray silt loam about 8 inches thick. Below this is a mixed layer about 3 inches thick. This layer is gray silty clay loam that has gray silt coatings on faces of peds. The subsoil is about 27 inches thick. The upper part is dark gray, firm silty clay. The lower part is light gray and light brownish gray, firm, calcareous silty clay loam that has nests of gypsum and other salts. The upper part of the underlying material is light gray, calcareous silt loam. The lower part to a depth of 60 inches is pale yellow, calcareous silt loam varved with silty clay to very fine sandy loam.

Typically, the surface layer of the Nahon soil is dark gray silt loam about 6 inches thick. The subsurface layer is gray silt loam about 3 inches thick. The subsoil is about 28 inches thick. The upper part is gray, firm silty clay and grayish brown, firm silty clay loam. The lower part is light brownish gray and pale yellow, firm and friable silty clay loam. It is calcareous and has nests of salt and gypsum. The underlying material to a depth of 60 inches is white and grayish brown, calcareous silty clay loam and clay varved with very fine sandy loam and silty clay.

Included with these soils in mapping are small areas of Bearden and Harmony soils. These included soils make up less than 10 percent of this map unit. They do not have a sodium-affected subsoil. Bearden soils contain less clay than the major soils. They are in positions on the landscape similar to those of the Exline soil. Harmony soils are in positions on the landscape similar to those of the Aberdeen soil.

The content of organic matter is moderate in the Exline, Aberdeen, and Nahon soils. Fertility is low in the Exline soil and medium in the Aberdeen and Nahon soils. All three soils have a sodium-affected subsoil. Tilth is poor in the Exline and Nahon soils and fair in the Aberdeen soil. Permeability is very slow in the Exline soil. It is slow in the subsoil of the Aberdeen soil and moderate to slow in the underlying material. It is very slow in the subsoil of the Nahon soil and moderately slow to very slow in the underlying material. Available water capacity is moderate in the Exline and Nahon soils and moderate or high in the Aberdeen soil. During wet periods, the Exline soil has a water table at a depth of 2.5 to 4.0 feet and the Aberdeen and Nahon

soils have one at a depth of 4.0 to 6.0 feet. Runoff is slow on all three soils. The shrink-swell potential is high in the subsoil. It is moderate in the underlying material of the Exline and Nahon soils and low in the underlying material of the Aberdeen soil.

Most of the acreage supports native grasses and is used for grazing. If these soils are used for range, the dense claypan subsoil in the Exline and Nahon soils limits productivity and the variety of suitable grasses. Surface compaction is a major problem on all three soils. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain productivity.

The Exline soil is generally unsuited to cultivated crops, tame pasture and hay, and windbreaks and environmental plantings. The dense claypan subsoil and the high content of salts restrict root penetration and the availability of plant nutrients. No trees or shrubs grow well on the Exline soil. The Aberdeen and Nahon soils are suited to cultivated crops, tame pasture and hay, and windbreaks and environmental plantings, but the sodium-affected subsoil is a limitation. Measures that improve tilth and increase the rate of water intake are the main management needs. Examples are tillage practices that leave crop residue on the surface, chiseling or subsoiling, timely tillage, and a cropping sequence that includes grasses and legumes. Trees and shrubs can be established on the Aberdeen and Nahon soil, but optimum growth, vigor, and survival are unlikely.

These soils are suited to building site development, but the high shrink-swell potential is a limitation. The wetness of the Exline soil is an additional limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

The Exline soil is generally unsuited to septic tank absorption fields because of the wetness and the restricted permeability. The Aberdeen and Nahon soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. The varves in the underlying material result in the slow absorption of liquid waste. Enlarging the absorption areas helps to overcome the slow absorption rate.

The Exline soil is in capability unit VIs-1, Thin Claypan range site, and windbreak suitability group 10; the Aberdeen soil is in capability unit IIIs-1, Clayey range site, and windbreak suitability group 4L; the Nahon soil is in capability unit IVs-2, Claypan range site, and windbreak suitability group 9.

EyA—Exline-Putney silt loams, 1 to 4 percent slopes. These deep, very gently sloping and gently sloping soils are on glacial lake plains. The moderately well drained Exline soil is on foot slopes, and the well drained Putney soil is on back slopes. Areas are 5 to 100 acres in size and are irregular in shape. They are 35 to 50 percent Exline soil and 30 to 40 percent Putney soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Exline soil is dark grayish brown silt loam about 8 inches thick. The subsoil is about 21 inches thick. The upper part is brown, very firm silty clay. The lower part is light gray, calcareous silty clay loam that has nests of salt. The underlying material to a depth of 60 inches is pale yellow, calcareous silt loam that is varved.

Typically, the surface layer of the Putney soil is dark gray silt loam about 8 inches thick. The subsoil is about 17 inches thick. The upper part is grayish brown, friable silty clay loam. The lower part is light gray, friable, calcareous silty clay loam and silt loam. It has nests of gypsum and other salts. The underlying material to a depth of 60 inches is pale yellow, calcareous silt loam that is varved in the lower part.

Included with these soils in mapping are small areas of Aberdeen, Bearden, Great Bend, Huffton, and Nahon soils. These included soils make up less than 20 percent of this map unit. Aberdeen, Great Bend, and Nahon soils are in positions on the landscape similar to those of the Putney soil. Aberdeen and Nahon soils contain more clay than the Putney soil and have a sodium-affected subsoil. Great Bend soils are well drained. The somewhat poorly drained Bearden soils are on toe slopes. They have a lower content of salts within a depth of 20 inches than the Putney soil. The well drained Huffton soils are on the higher convex parts of the landscape. They contain less clay than the Exline and Putney soils.

The content of organic matter is moderate in the Exline and Putney soils. Fertility is low in the Exline soil and medium in the Putney soil. The Exline soil has a sodium-affected subsoil. Tilth is poor in the Exline soil and good in the Putney soil. Permeability is very slow in the Exline soil. It is moderate in the subsoil of the Putney soil and moderate to slow in the underlying material. Available water capacity is moderate in the Exline soil and high in the Putney soil. Runoff is slow on both soils. The shrink-swell potential is high in the subsoil of the Exline soil and moderate in the underlying material. It is moderate in the subsoil of the Putney soil and low in the underlying material.

Most of the acreage is cropland. The Exline soil is

generally unsuited to cultivated crops and to tame pasture and hay because the dense, sodium-affected subsoil restricts root development and the availability of plant nutrients. No crops grow well on this soil. The Putney soil is suited to cultivated crops and to tame pasture and hay, but the high content of salts in the subsoil restricts the availability of water and plant nutrients. Alfalfa, intermediate wheatgrass, and smooth brome are examples of suitable pasture plants. Wheat, barley, sunflowers, and oats are the main crops. Measures that control erosion, maintain fertility, and conserve moisture are the main management needs on the Putney soil. Examples are applying animal manure, leaving crop residue on the surface, minimizing tillage, and including grasses and legumes in the cropping sequence.

If these soils are used for range, the dense claypan subsoil in the Exline soil and the high content of salts in both soils limit productivity and the variety of suitable grasses. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain productivity.

The Exline soil is generally unsuited to windbreaks and environmental plantings because the dense claypan subsoil and the high content of salts restrict root development and the availability of plant nutrients. No trees or shrubs grow well on the Exline soil. Except for the species that require an abundant supply of moisture, all climatically suited trees and shrubs grow well on the Putney soil.

These soils are suited to building site development, but the moderate or high shrink-swell potential is a limitation in areas of the Exline soil. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. The varves in the underlying material result in the slow absorption of liquid waste. Enlarging the absorption area helps to overcome the slow absorption rate.

The Exline soil is in capability unit VIs-1, Thin Claypan range site, and windbreak suitability group 10; the Putney soil is in capability unit IIe-5, Silty range site, and windbreak suitability group 3.

Fe—Ferney-Heil complex. These deep, level and nearly level soils are on till plains. The somewhat poorly drained Ferney soil is on the lower foot slopes, and the poorly drained Heil soil is in basins. The Heil soil is ponded during periods of snowmelt and after heavy rains. Areas of this map unit are irregular in shape and range from 10 to 100 acres in size. They are 50 to 60 percent Ferney soil and 25 to 35 percent Heil soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Ferney soil is dark gray clay loam about 5 inches thick. The subsoil is clay loam about 45 inches thick. The upper part is very dark grayish brown and very firm. The lower part is grayish brown and light yellowish brown, firm, and calcareous. It has nests of salt. The underlying material to a depth of 60 inches is light yellowish brown, calcareous clay loam.

Typically, the surface layer of the Heil soil is gray silt loam about 2 inches thick. The subsoil is dark gray, very firm silty clay about 33 inches thick. The lower part has nests of salt. It is calcareous below a depth of 26 inches. The underlying material to a depth of 60 inches is gray and light gray, calcareous clay loam.

Included with these soils in mapping are small areas of Nishon, Niobell, and Noonan soils. These included soils make up less than 15 percent of this map unit. Nishon soils do not have a sodium-affected subsoil. They are in positions on the landscape similar to those of the Ferney soil. The moderately well drained Niobell and Noonan soils are on back slopes.

The content of organic matter is moderate in the Ferney and Heil soils. Fertility is low or medium in the Ferney soil and medium in the Heil soil. Both soils have a dense, sodium-affected subsoil. Tilth is poor. Permeability is very slow in both soils. Available water capacity is moderate. During wet periods, the Ferney soil has a water table at a depth of 2 to 4 feet and the Heil soil has one within a depth of 1 foot. As much as 1 foot of water may pond on the Heil soil. Runoff is slow on the Ferney soil and ponded on the Heil soil. The shrink-swell potential is high in both soils.

Most of the acreage supports native grasses and is used for grazing. If these soils are used for range, the dense, sodium-affected subsoil in both soils and the ponding on the Heil soil affect the productivity and the variety of suitable grasses. Surface compaction is a problem on both soils. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are generally unsuited to cultivated crops and to windbreaks and environmental plantings. The dense, sodium-affected subsoil in both soils and the ponding on the Heil soil are the main limitations.

These soils are poorly suited to tame pasture and hay. Very limited production can be expected in areas of the Ferney soil. The choice of hay and tame pasture plants is limited because natural drainage is restricted,

the surface layer is thin, and the subsoil is dense and compact. Garrison creeping foxtail and western wheatgrass are examples of suitable pasture plants.

The Ferney soil is suited to building site development, but the high shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

The Ferney soil is suited to septic tank absorption fields, but the restricted permeability is a limitation. The absorption fields generally do not function well unless they are significantly enlarged.

The Heil soil is generally unsuited to septic tank absorption fields and building site development because of the ponding.

The Ferney soil is in capability unit VIs-1, Thin Claypan range site, and windbreak suitability group 10; the Heil soil is in capability unit VIw-4, Closed Depression range site, and windbreak suitability group 10.

Fo—Fordville loam. This well drained, nearly level and very gently sloping soil is on outwash plains and terraces. It is moderately deep over gravelly sand. Areas are irregular in shape and range from 10 to 150 acres in size. Slopes are smooth or slightly convex.

Typically, the surface layer is dark gray loam about 8 inches thick. The subsoil is dark grayish brown and brown, friable clay loam about 16 inches thick. The underlying material to a depth of 60 inches is pale brown, calcareous gravelly sand.

Included with this soil in mapping are small areas of Divide and Renshaw soils. These soils make up less than 15 percent of this map unit. Divide soils have free lime within a depth of 16 inches. They are on toe slopes. Renshaw soils are dark to a depth of less than 16 inches and are less than 20 inches to gravelly sand. They are on back slopes.

The content of organic matter is moderate in the Fordville soil, and fertility is medium. Because of the porous underlying material, root penetration is restricted and the soil is somewhat droughty. Available water capacity is low or moderate. Permeability is moderate in the subsoil and rapid in the underlying material. Runoff is slow. The shrink-swell potential is low.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. The low available water capacity is a limitation. Alfalfa, intermediate wheatgrass, crested wheatgrass, and pubescent wheatgrass are examples of suitable pasture plants. Wheat, oats, and corn are the main crops. Measures that conserve moisture are the main management needs. Examples are tillage practices that leave crop residue on the surface and minimum tillage. The soil is well suited to irrigation.

No major hazards or limitations affect the use of this soil for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to windbreaks and environmental plantings, but droughtiness is a limitation. No trees or shrubs grow well. Windbreaks and environmental plantings can be established, but optimum growth, survival, and vigor are unlikely.

This soil is suited to most kinds of building site development, but the sides of shallow excavations tend to cave in unless they are shored. The soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. The soil is a probable source of sand and gravel for road construction.

This soil is in capability unit IIIs-2, Silty range site, and windbreak suitability group 6G.

FsA—Forman-Aastad loams, 0 to 3 percent slopes. These deep, level to gently undulating soils are on till plains. The well drained Forman soil is on back slopes, and the moderately well drained Aastad soil is on foot slopes. Areas are irregular in shape and range from 20 to 200 acres in size. They are 40 to 50 percent Forman soil and 35 to 45 percent Aastad soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Forman soil is dark gray loam about 8 inches thick. The subsoil is grayish brown, friable clay loam about 20 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light yellowish brown and pale yellow, calcareous clay loam. In places the subsoil has more clay.

Typically, the surface layer of the Aastad soil is dark gray loam about 12 inches thick. The subsoil is clay loam about 33 inches thick. The upper part is dark grayish brown and grayish brown and is friable. The next part is light brownish gray, friable, and calcareous. The lower part is light yellowish brown, firm, and calcareous. The underlying material to a depth of 60 inches is light yellowish brown, calcareous clay loam.

Included with these soils in mapping are small areas of Buse, Cavour, Cresbard, and Tonka soils. These included soils make up less than 15 percent of this map unit. Buse soils have free lime at the surface and are on shoulder slopes. Cavour and Cresbard soils have more clay in the subsoil than the Forman and Aastad soils and have a sodium-affected subsoil. They are in

positions on the landscape similar to those of the Aastad soil. The poorly drained Tonka soils are in basins.

The content of organic matter is moderate in the Forman soil and high in the Aastad soil. Fertility is medium in the Forman soil and high in the Aastad soil. Permeability is moderate in the subsoil of the Forman soil and moderately slow in the underlying material. It is moderately slow in the Aastad soil. Available water capacity is high in both soils. The Aastad soil has a water table at a depth of 3 to 6 feet during wet periods. Runoff is slow on both soils. The shrink-swell potential is moderate.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Alfalfa, intermediate wheatgrass, and smooth brome are suitable pasture plants. Wheat, corn, barley, and oats are the main crops. Because of runoff from the adjacent soils, planting and harvesting are delayed on the Aastad soil during some wet periods. Measures that conserve moisture are the main management needs on the Forman soil. Examples are tillage practices that leave crop residue on the surface.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Forman soil, except for those that require an abundant supply of moisture. The Aastad soil is especially well suited to the species that require an abundant supply of moisture.

The Forman soil is suited to building site development, but the moderate shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. The Forman soil is suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Aastad soil is generally unsuitable as a site for buildings and sanitary facilities because it is subject to very brief periods of overland flow.

The Forman soil is in capability unit IIc-2, Silty range site, and windbreak suitability group 3; the Aastad soil is in capability unit IIc-3, Overflow range site, and windbreak suitability group 1.

FsB—Forman-Aastad loams, 1 to 6 percent slopes. These deep, gently undulating and undulating soils are on till plains. The well drained Forman soil is on back slopes, and the moderately well drained Aastad soil is on foot slopes. Areas are irregular in shape and range from 10 to 150 acres in size. They are 50 to 65 percent Forman soil and 20 to 35 percent Aastad soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Forman soil is dark gray loam about 8 inches thick. The subsoil is grayish brown, friable clay loam about 20 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light yellowish brown and pale yellow, calcareous clay loam. In places the subsoil has more clay.

Typically, the surface layer of the Aastad soil is dark gray loam about 12 inches thick. The subsoil is clay loam about 33 inches thick. The upper part is dark grayish brown and grayish brown and is friable. The next part is light brownish gray, friable, and calcareous. The lower part is light yellowish brown, firm, and calcareous. The underlying material to a depth of 60 inches is light yellowish brown, calcareous clay loam.

Included with these soils in mapping are small areas of Buse, Cavour, Cresbard, and Tonka soils. These included soils make up less than 15 percent of this map unit. Buse soils have lime at the surface. They are on shoulder slopes. Cavour and Cresbard soils have a sodium-affected subsoil. They are in positions on the landscape similar to those of the Aastad soil. The poorly drained Tonka soils are in basins.

The content of organic matter is moderate in the Forman soil and high in the Aastad soil. Fertility is medium in the Forman soil and high in the Aastad soil. Permeability is moderate in the subsoil of the Forman soil and moderately slow in the underlying material. It is moderately slow in the Aastad soil. Available water capacity is high in both soils. The Aastad soil has a water table at a depth of 3 to 6 feet during wet periods. Runoff is medium on the Forman soil and slow on the Aastad soil. The shrink-swell potential is moderate in both soils.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Alfalfa, intermediate wheatgrass, and smooth brome are suitable pasture plants. Because of runoff from the adjacent soils, planting and harvesting are delayed during some wet periods on the Aastad soil. Wheat, corn, barley, and oats are the main crops. The main management needs are controlling erosion and conserving moisture. Tillage practices that leave crop residue on the surface help to control erosion and conserve moisture. Contour farming and terraces can help to control erosion, but in most areas the slopes are too short and irregular for contouring and terracing.

Grassed waterways help to keep gullies from forming.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Forman soil, except for those that require an abundant supply of moisture. The Aastad soil is especially well suited to the species that require an abundant supply of moisture.

The Forman soil is suited to building site development, but the moderate shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. The Forman soil is suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Aastad soil is generally unsuitable as a site for buildings and sanitary facilities because it is subject to overland flow.

The Forman soil is in capability unit IIe-2, Silty range site, and windbreak suitability group 3; the Aastad soil is in capability unit IIc-3, Overflow range site, and windbreak suitability group 1.

FtC—Forman-Buse-Aastad loams, 2 to 9 percent slopes. These deep, gently undulating to gently rolling soils are on moraines. The well drained Forman soil is on back slopes, the well drained Buse soil is on shoulder slopes, and the moderately well drained Aastad soil is on foot slopes. Areas are irregular in shape and range from 5 to 35 acres in size. They are 35 to 45 percent Forman soil, 20 to 30 percent Buse soil, and 15 to 25 percent Aastad soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Forman soil is dark gray loam about 8 inches thick. The subsoil is grayish brown, friable clay loam about 20 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light yellowish brown and pale yellow, calcareous clay loam. In places the subsoil has more clay.

Typically, the surface layer of the Buse soil is dark gray, calcareous loam about 7 inches thick. The subsoil is pale brown, calcareous loam about 15 inches thick. The underlying material to a depth of 60 inches is light yellowish brown, calcareous loam. In places the soil contains more clay.

Typically, the surface layer of the Aastad soil is dark gray loam about 12 inches thick. The subsoil is clay loam about 33 inches thick. The upper part is dark grayish brown and grayish brown and is friable. The next part is light brownish gray, friable, and calcareous. The lower part is light yellowish brown, firm, and calcareous. The underlying material to a depth of 60 inches is light yellowish brown, calcareous clay loam.

Included with these soils in mapping are small areas of Cresbard soils. These included soils make up less than 15 percent of this map unit. They have a sodium-affected subsoil. They are in positions on the landscape similar to those of the Aastad soil.

The content of organic matter is moderate in the Forman soil, low to moderate in the Buse soil, and high in the Aastad soil. Fertility is medium in the Forman soil, medium or low in the Buse soil, and high in the Aastad soil. Permeability is moderate in the subsoil of the Forman soil and moderately slow in the underlying material. It is moderately slow in the Buse and Aastad soils. Available water capacity is high in all three soils. The Aastad soil has a water table at a depth of 3 to 6 feet during wet periods. Runoff is rapid on the Forman and Buse soils and slow on the Aastad soil. The shrink-swell potential is moderate in all three soils.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Alfalfa, intermediate wheatgrass, and smooth brome are suitable pasture plants. Wheat, corn, barley, and oats are the main crops. A high content of lime in the surface layer of the Buse soil limits productivity by restricting the availability of plant nutrients. The Forman and Buse soils are subject to rapid runoff. Because of runoff from the adjacent soils, planting and harvesting are delayed on the Aastad soil during some wet periods. The additional moisture is beneficial, however, in most years. The main concern in managing cultivated areas is controlling erosion. Improving the fertility of the Buse soil also is a management concern. Erosion can be controlled by leaving crop residue on the surface, minimizing tillage, and including grasses and legumes in the cropping sequence. Contour farming, grassed waterways, and terraces also help to control erosion, but in most areas the slopes are too short or too irregular for contouring and terracing.

No major hazards or limitations affect the use of these soils for range. Water erosion is a hazard, however, if the range is overgrazed. Gullies form along some cattle trails. Fencing and other means of controlling livestock traffic patterns help to keep gullies from forming.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and

shrubs grow well on the Forman soil, except for those that require an abundant supply of moisture. The Aastad soil is especially well suited to the species that require an abundant supply of moisture. The high content of lime in the surface layer of the Buse soil is a limitation. Trees and shrubs can be established on this soil, but optimum survival, growth, and vigor are unlikely.

The Forman and Buse soils are suited to building site development, but the moderate shrink-swell potential and the slope are limitations. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. Buildings should be designed so that they conform to the natural slope of the land. In some areas land shaping is needed.

The restricted permeability and the slope are limitations if the Forman and Buse soils are used as sites for septic tank absorption fields. Enlarging the absorption area helps to overcome a slow absorption rate. Land shaping and installing the distribution lines across the slope generally improve the efficiency of the absorption system.

The Aastad soil is generally unsuited to building site development and septic tank absorption fields because it is subject to overland flow.

The Forman soil is in capability unit IIIe-2, Silty range site, and windbreak suitability group 3; the Buse soil is in capability unit IVe-3, Thin Upland range site, and windbreak suitability group 8; the Aastad soil is in capability unit IIc-3, Silty range site, and windbreak suitability group 1.

Fy—Fossum fine sandy loam. This deep, poorly drained and very poorly drained, level, sandy soil is on glacial lake plains. It is subject to rare flooding. Areas are circular, oval, or long and narrow and range from 5 to 120 acres in size.

Typically, the surface layer is very dark gray, calcareous fine sandy loam about 8 inches thick. The subsurface layer is very dark gray, calcareous loamy fine sand about 6 inches thick. Below this is a transitional layer of gray, calcareous fine sand about 16 inches thick. The underlying material to a depth of 60 inches is light gray and gray, calcareous fine sand.

Included with this soil in mapping are small areas of Stirum and Ulen soils. These soils make up less than 10 percent of this map unit. Stirum soils have a sodium-affected subsoil. They are on the slightly higher parts of the landscape. The somewhat poorly drained and moderately well drained Ulen soils are on the lower toe slopes.

The content of organic matter is moderate in the Fossum soil, and fertility is medium. Permeability is rapid. Available water capacity is low. A seasonal high water table is at a depth of 1.0 to 2.5 feet during wet periods. Runoff is slow or very slow. The shrink-swell potential is low.

Most of the acreage supports native grasses and is used for grazing. A few small areas are cultivated along with the adjacent areas. No major hazards or limitations affect the use of this soil for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to tame pasture and hay, but the wetness is a limitation. Because the soil generally cannot be artificially drained, the choice of tame pasture plants is limited to water-tolerant species. Garrison creeping foxtail and reed canarygrass are examples.

This soil is generally unsuited to cultivated crops, windbreaks and environmental plantings, building site development, and septic tank absorption fields because of the wetness.

This soil is in capability unit Vw-3, Subirrigated range site, and windbreak suitability group 10.

Ga—Gardena very fine sandy loam. This deep, well drained and moderately well drained, level and nearly level soil is on glacial lake plains. Areas are irregular in shape and range from 20 to more than 300 acres in size. Slopes are smooth and flat or slightly concave.

Typically, the surface layer is dark gray very fine sandy loam about 8 inches thick. The subsurface layer also is dark gray very fine sandy loam. It is about 12 inches thick. The subsoil is grayish brown and light gray, friable silt loam about 24 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light gray, calcareous silt loam. In places the soil is dark to a depth of less than 16 inches.

Included with this soil in mapping are small areas of Embden and Glyndon soils. These soils make up less than 15 percent of this map unit. Embden soils contain more sand between depths of 10 and 40 inches than the Gardena soil. They are in positions on the landscape similar to those of the Gardena soil. Glyndon soils have free lime at the surface. They are on toe slopes.

The content of organic matter and fertility are high in the Gardena soil. Permeability is moderate. Available water capacity is high. The water table is at a depth of 4 to 6 feet during wet periods. Runoff is slow. The shrink-swell potential is low.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay.

Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, soybeans, and oats are the main crops. Measures that control wind erosion and conserve moisture are the main management needs. Tillage practices that leave crop residue on the surface, field windbreaks, and stripcropping are examples.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, and the species that require an abundant supply of moisture grow especially well.

No major hazards or limitations affect the use of this soil for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to most kinds of building site development, but wetness is a limitation on sites for dwellings with basements. Installing foundation drains and diverting runoff away from the buildings help to prevent the damage caused by wetness. Septic tank absorption fields can be constructed in areas of this soil, but the seasonal high water table is a limitation.

This soil is in capability unit IIe-6, Silty range site, and windbreak suitability group 1.

Gc—Gardena-Glyndon silt loams. These deep, level to very gently sloping soils are on glacial lake plains. Slopes are 0 to 3 percent. The well drained and moderately well drained Gardena soil is on foot slopes, and the moderately well drained and somewhat poorly drained Glyndon soil is on the lower toe slopes. Areas are irregular in shape and range from 20 to 200 acres in size. They are 50 to 70 percent Gardena soil and 25 to 40 percent Glyndon soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Gardena soil is dark gray silt loam about 8 inches thick. The subsurface layer also is dark gray silt loam. It is about 12 inches thick. The subsoil is grayish brown and light gray, friable silt loam about 24 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light gray, calcareous silt loam. In places the soil is dark to a depth of less than 16 inches.

Typically, the surface layer of the Glyndon soil is dark gray, calcareous silt loam about 8 inches thick. The subsurface layer also is dark gray, calcareous silt loam. It is about 6 inches thick. The subsoil is white and light gray, friable, calcareous silt loam about 24 inches thick. The underlying material to a depth of 60 inches is light gray, calcareous silt loam.

Included with these soils in mapping are small areas of Borup and Embden soils. These included soils make up less than 15 percent of this map unit. The poorly drained Borup soils are in shallow basins. Embden soils are in positions on the landscape similar to those of the Gardena soil. They contain more sand and less silt than the Gardena soil.

The content of organic matter is high in the Gardena and Glyndon soils. Fertility is high in the Gardena soil and medium in the Glyndon soil. Permeability is moderate in the Gardena soil and moderate or moderately rapid in the Glyndon soil. Available water capacity is high in both soils. During wet periods, the Gardena soil has a water table at a depth of 4.0 to 6.0 feet and the Glyndon soil has one at a depth of 2.5 to 6.0 feet. Runoff is slow on both soils. The shrink-swell potential is low.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, barley, and oats are the main crops. The main management needs are controlling erosion, conserving moisture in the Gardena soil, and maintaining fertility. The wetness of the Glyndon soil commonly delays spring planting and tillage. A high content of lime in the upper part of the Glyndon soil restricts the availability of plant nutrients and increases the susceptibility to wind erosion. Tillage practices that leave crop residue on the surface conserve moisture, help to maintain fertility, and help to control erosion. Stripcropping also conserves moisture and helps to control wind erosion. Including grasses and legumes in the cropping sequence helps to control erosion and maintain fertility. Field windbreaks also help to control wind erosion.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, and those that require an abundant supply of moisture grow especially well.

No major hazards or limitations affect the use of this soil for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suitable as sites for buildings without basements. Seepage caused by the high water table is a limitation on sites for buildings with basements. Installing foundation drains and diverting runoff away from the buildings help to prevent seepage. Where possible, buildings should be constructed on the higher, better drained adjacent soils.

The Glyndon soil is generally unsuited to septic tank absorption fields because of the wetness. Septic tank absorption fields can be constructed on the Gardena soil, but the seasonal high water table is a limitation.

The Gardena soil is in capability unit IIc-3, Silty range site, and windbreak suitability group 1; the Glyndon soil

is in capability unit IIe-4, Limy Subirrigated range site, and windbreak suitability group 1.

Gh—Gardena-Turton very fine sandy loams. These deep, level and nearly level soils are on glacial lake plains. The well drained and moderately well drained Gardena soil is on the upper foot slopes and lower back slopes. The moderately well drained Turton soil is on the lower foot slopes. Areas are irregular in shape and range from 10 to 75 acres in size. They are 45 to 55 percent Gardena soil and 25 to 35 percent Turton soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Gardena soil is dark gray very fine sandy loam about 8 inches thick. The subsurface layer also is dark gray very fine sandy loam. It is about 12 inches thick. The subsoil is grayish brown and light gray, friable silt loam about 24 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light gray, calcareous silt loam.

Typically, the surface layer of the Turton soil is dark gray very fine sandy loam about 7 inches thick. The subsurface layer also is dark gray very fine sandy loam. It is about 8 inches thick. The next layer is gray very fine sandy loam about 4 inches thick. The subsoil is friable loam about 28 inches thick. The upper part is grayish brown. The lower part is grayish brown and light brownish gray and is calcareous. It has crystals and nests of salt. The underlying material to a depth of 60 inches is light gray, calcareous very fine sandy loam that has crystals of salt.

Included with these soils in mapping are small areas of Camtown, Embden, Glyndon, Turton Variant, and Stirum soils. These included soils make up less than 20 percent of this map unit. Camtown and Embden soils are in landscape positions similar to those of the Gardena soil. Camtown soils do not have columnar structure in the subsoil. Embden soils contain more sand between depths of 10 and 40 inches than the Gardena soil. Glyndon, Turton Variant, and Stirum soils are slightly lower on the landscape than the Gardena and Turton soils. Glyndon soils have free lime at the surface. The somewhat poorly drained Turton Variant soils have visible salts within a depth of 16 inches. The poorly drained Stirum soils have more sand in the subsoil than the Turton soil.

The content of organic matter is high in the Gardena soil and moderate in the Turton soil. Fertility is high in the Gardena soil and medium in the Turton soil. The Turton soil has a sodium-affected subsoil. Tilth is poor in this soil. Permeability is moderate in the Gardena soil. It is slow in the subsoil of the Turton soil and moderate to slow in the underlying material. Available water capacity is high in the Gardena soil and moderate or high in the Turton soil. During wet periods the water table is at a depth of 4 to 6 feet in both soils. Runoff is slow. The shrink-swell potential is low in the Gardena soil and moderate in the Turton soil.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, pubescent wheatgrass, and crested wheatgrass. Wheat, corn, barley, and oats are the main crops. The sodium-affected subsoil in the Turton soil restricts root penetration and the rate of water intake. Measures that control wind erosion and conserve moisture are the main management needs. Examples are tillage practices that leave crop residue on the surface, minimum tillage, and a cropping sequence that includes grasses and legumes. Field windbreaks and stripcropping help to control wind erosion. Other management needs are measures that increase the rate of water intake and improve tilth in the Turton soil. Examples are chiseling and subsoiling.

If these soils are used for range, the claypan subsoil in the Turton soil limits productivity and the variety of suitable grasses. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings, but the sodium-affected subsoil in the Turton soil limits root penetration. All climatically suited trees and shrubs grow well on the Gardena soil, and those that require an abundant supply of moisture grow especially well. Trees and shrubs can be established on the Turton soil, but optimum survival, growth, and vigor are unlikely.

These soils are suited to building site development, but the wetness is a limitation on sites for buildings with basements. The moderate shrink-swell potential in the Turton soil is an additional limitation on sites for buildings with basements. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by wetness and by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are generally unsuited to septic tank absorption fields because of the wetness and the restricted permeability.

The Gardena soil is in capability unit IIe-6, Silty range site, and windbreak suitability group 1; the Turton soil is in capability unit IVs-2, Claypan range site, and windbreak suitability group 9.

Gm—Glyndon silt loam. This deep, level to very gently sloping, moderately well drained and somewhat

poorly drained soil is on glacial lake plains. Areas are circular or irregularly shaped and range from 10 to 30 acres in size. Slopes are 0 to 3 percent and are long and smooth.

Typically, the surface layer is dark gray, calcareous silt loam about 8 inches thick. The subsurface layer also is dark gray, calcareous silt loam. It is about 6 inches thick. The subsoil is white and light gray, friable, calcareous silt loam about 24 inches thick. The underlying material to a depth of 60 inches is light gray, calcareous silt loam.

Included with this soil in mapping are small areas of Borup and Gardena soils. These soils make up less than 15 percent of this map unit. The poorly drained and very poorly drained Borup soils are on the slightly lower parts of the landscape, and the well drained and moderately well drained Gardena soils are on the slightly higher parts.

The content of organic matter is high in the Glyndon soil, and fertility is medium. Permeability is moderate or moderately rapid. Available water capacity is high. The water table is at a depth of 2.5 to 6.0 feet during wet periods. Runoff is slow. The shrink-swell potential is low.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, big bluestem, and smooth brome. Wheat, barley, and oats are the main crops. Wetness commonly delays spring planting and tillage. A high concentration of lime in the upper part of the soil restricts the availability of plant nutrients. Measures that control wind erosion and maintain fertility are the main management concerns. Tillage practices that leave crop residue on the surface help to control erosion, conserve moisture during dry periods, and improve fertility. Stripcropping also helps to control wind erosion.

No major hazards or limitations affect the use of this soil for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to windbreaks and environmental plantings. All climatically suited species of trees and shrubs grow well on this soil, especially those that require an abundant supply of moisture.

This soil is suited to most kinds of building site development, but the wetness is a limitation on sites for dwellings with basements. Installing foundation drains and diverting runoff away from the buildings help to prevent the structural damage caused by wetness. Where possible, buildings should be constructed on the higher, better drained adjacent soils. The soil is generally unsuited to septic tank absorption fields because of the wetness.

This soil is in capability unit IIe-4, Limy Subirrigated range site, and windbreak suitability group 1.

Gn—Glyndon silt loam, saline. This deep, level and nearly level, moderately well drained and somewhat poorly drained soil is on glacial lake plains. Areas are irregular in shape and range from 10 to 150 acres in size. Slopes are long and smooth.

Typically, the surface layer is dark gray, calcareous silt loam about 8 inches thick. The subsurface layer also is dark gray, calcareous silt loam. It is about 6 inches thick. The subsoil is white and light gray, friable, calcareous silt loam about 24 inches thick. The underlying material to a depth of 60 inches is light gray, calcareous silt loam. The soil has nests of salt throughout.

Included with this soil in mapping are small areas of Borup, Gardena, and Stirum soils. These soils make up less than 15 percent of this map unit. The poorly drained and very poorly drained Borup soils are on the slightly lower parts of the landscape, and the well drained and moderately well drained Gardena soils are on the slightly higher parts. Stirum soils have a sodium-affected subsoil. They are on the slightly lower parts of the landscape.

The content of organic matter is high in the Glyndon soil, and fertility is low. Permeability is moderate or moderately rapid. Available water capacity is moderate. The water table is at a depth of 2.5 to 6.0 feet during wet periods. Runoff is slow. The shrink-swell potential is low.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay, but the high content of salts is a limitation. Tall wheatgrass, creeping foxtail, and switchgrass are suitable species. Barley and rye are the main crops. The main management needs are measures that control wind erosion and improve fertility. The high content of salts inhibits plant growth, and a high content of lime in the surface layer restricts the availability of plant nutrients and increases the susceptibility to wind erosion. Tillage practices that leave crop residue on the surface help to control wind erosion, conserve moisture, and improve fertility. Stripcropping also helps to control wind erosion.

Some areas support native grasses and are used for grazing. The salinity limits productivity and the variety of suitable grasses. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is generally unsuited to windbreaks and environmental plantings because of the high content of salt.

This soil is generally unsuited to building site development and septic tank absorption fields because

of the wetness. Sites that are better suited generally are available on the adjacent uplands.

This soil is in capability unit IIIs-6, Saline Subirrigated range site, and windbreak suitability group 10.

GrA—Great Bend silt loam, 0 to 2 percent slopes. This deep, well drained, nearly level soil is on glacial lake plains. Areas are irregular in shape and range from 60 to more than 1,000 acres in size. Slopes are smooth.

Typically, the surface layer is grayish brown silt loam about 8 inches thick. The subsoil is about 21 inches thick. It is friable. The upper part is grayish brown silty clay loam. The lower part is pale yellow, calcareous silt loam. The underlying material to a depth of 60 inches is light gray, white, and light olive brown, calcareous silt loam varved with very fine sandy loam and silty clay. In places the soil is dark to a depth of more than 16 inches.

Included with this soil in mapping are small areas of Bearden, Putney, and Harmony soils. These soils make up less than 10 percent of this map unit. The somewhat poorly drained Bearden soils are on toe slopes. They have lime at the surface. Putney soils have salts within a depth of 20 inches. They are in positions on the landscape similar to those of the Great Bend soil. Harmony soils contain more clay in the subsoil than the Great Bend soil. They are on the slightly lower parts of the landscape.

The content of organic matter is moderate in the Great Bend soil, and fertility is medium or high. Available water capacity is high. Permeability is moderate in the subsoil and moderate to slow in the underlying material. Runoff is slow. The shrink-swell potential is moderate in the subsoil and low in the underlying material.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Alfalfa, intermediate wheatgrass, and smooth brome are suitable pasture plants. Wheat, corn, soybeans, sunflowers, and oats are the main crops. The main management needs are measures that conserve moisture. Leaving crop residue on the surface and minimizing tillage are examples.

No major hazards or limitations affect the use of this soil for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain productivity.

This soil is well suited to windbreaks and environmental plantings (fig. 9). All climatically suited trees and shrubs grow well, except for those that require an abundant supply of moisture.

The Great Bend soil is suited to building site development. It is suited to septic tank absorption fields, but the restricted permeability is a limitation. The varves in the underlying material result in the slow absorption of liquid waste. Enlarging the absorption area helps to overcome the slow absorption rate.

This soil is in capability unit IIc-2, Silty range site, and windbreak suitability group 3.

GsB—Great Bend-Beotia silt loams, 2 to 6 percent slopes. These deep, well drained, gently sloping soils are on glacial lake plains. The Great Bend soil is on back slopes, and the Beotia soil is on foot slopes. Areas are irregular in shape and range from 10 to 200 acres in size. They are 45 to 60 percent Great Bend soil and 35 to 55 percent Beotia soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Great Bend soil is grayish brown silt loam about 8 inches thick. The subsoil is about 21 inches thick. It is friable. The upper part is grayish brown silty clay loam. The lower part is pale yellow, calcareous silt loam. The underlying material to a depth of 60 inches is light gray, white, and light olive brown, calcareous silt loam varved with very fine sandy loam and silty clay.

Typically, the surface layer of the Beotia soil is dark gray silt loam about 11 inches thick. The subsoil is about 31 inches thick. It is friable. The upper part is grayish brown silty clay loam and silt loam. The lower part is pale yellow, calcareous silt loam. The underlying material to a depth of 60 inches is pale yellow, calcareous silt loam varved with very fine sandy loam and silty clay.

Included with these soils in mapping are small areas of Bearden, Putney, and Zell soils. These included soils make up less than 15 percent of this map unit. The somewhat poorly drained Bearden soils are on the lower toe slopes. Putney soils have salts within a depth of 20 inches. They are in positions on the landscape similar to those of the Great Bend soil. Zell soils have free lime at the surface. They are on shoulder slopes.

The content of organic matter is moderate in the Great Bend soil and high in the Beotia soil. Fertility is medium or high in the Great Bend soil and high in the Beotia soil. Permeability is moderate in the subsoil of both soils and moderate to slow in the underlying material. Available water capacity is high. Runoff is medium on the Great Bend soil and slow on the Beotia soil. The shrink-swell potential is moderate in the subsoil of both soils and low in the underlying material.

Most areas are used as cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, soybeans, sunflowers, and oats are the main

Figure 9.—Field windbreaks in an area of Great Bend silt loam, 0 to 2 percent slopes.

crops. Measures that control erosion and conserve moisture are the main management needs. Examples are tillage practices that leave crop residue on the surface and minimum tillage. Where the slopes are suitable, contour farming, terraces, and grassed waterways help to control erosion.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings. All the climatically suited trees and shrubs grow well, except for those that require an abundant supply of moisture.

The Great Bend soil is suited to building site development. The Beotia soil is suited to most kinds of building site development, but the moderate shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. The varves in the underlying material result in the slow absorption of liquid waste. Enlarging the absorption area helps to overcome the slow absorption rate.

The Great Bend soil is in capability unit IIe-1, Silty range site, and windbreak suitability group 3; the Beotia soil is in capability unit IIe-3, Silty range site, and windbreak suitability group 3.

GtA—Great Bend-Putney silt loams, 0 to 2 percent slopes. These deep, level and nearly level, well drained soils are on glacial lake plains. Areas are irregular in shape and range from 100 to more than 1,000 acres in size. They are 45 to 55 percent Great Bend soil and 25 to 35 percent Putney soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Great Bend soil is grayish brown silt loam about 8 inches thick. The subsoil is about 21 inches thick. It is friable. The upper part is grayish brown silty clay loam. The lower part is pale yellow, calcareous silt loam. The underlying material to a depth of 60 inches is light gray, white, and light olive brown, calcareous silt loam varved with very fine sandy loam and silty clay. In places the soil is dark to a depth of more than 16 inches.

Typically, the surface layer of the Putney soil is dark gray silt loam about 8 inches thick. The subsoil is about 17 inches thick. The upper part is grayish brown, friable silty clay loam. The lower part is light gray, friable, calcareous silty clay loam and silt loam. It has nests of gypsum and other salts. The underlying material to a depth of 60 inches is pale yellow, calcareous silt loam that is varved.

Included with these soils in mapping are small areas of Aberdeen, Bearden, and Harmony soils. These included soils make up less than 20 percent of this map unit. Aberdeen soils have a sodium-affected subsoil. They are in the slightly lower positions on the landscape. The somewhat poorly drained Bearden soils are on the lower toe slopes. They have free lime at the surface. Harmony soils have more clay in the subsoil than the Great Bend and Putney soils. Also, they are in slightly lower positions on the landscape.

The content of organic matter is moderate in the Great Bend and Putney soils. Fertility is medium or high in the Great Bend soil and medium in the Putney soil. Permeability is moderate in the subsoil of both soils and moderate to slow in the underlying material. Available water capacity is high. Runoff is slow. The shrink-swell potential is moderate in the subsoil and low in the underlying material.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, soybeans, sunflowers, and oats are the main crops. The high content of salts in the subsoil of the Putney soil restricts the availability of water and plant nutrients. The main management concerns are conserving moisture in both soils and maintaining fertility in the Putney soil. Examples are tillage practices that leave crop residue on the surface.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, except for those that require an abundant supply of moisture.

These soils are suited to building site development. They are suited to septic tank absorption fields, but the restricted permeability is a limitation. The varves in the underlying material result in the slow absorption of liquid waste. Enlarging the absorption area helps to overcome the slow absorption rate.

The Great Bend soil is in capability unit IIc-2, Silty range site, and windbreak suitability group 3; the Putney soil is in capability unit IIs-3, Silty range site, and windbreak suitability group 3.

GyB—Great Bend-Zell silt loams, 2 to 6 percent slopes. These deep, well drained, gently sloping soils are on glacial lake plains. The Great Bend soil is on back slopes, and the Zell soil is on shoulder slopes. Areas are elongated or irregularly shaped and range from 5 to 50 acres in size. They are 60 to 70 percent Great Bend soil and 20 to 30 percent Zell soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Great Bend soil is grayish brown silt loam about 8 inches thick. The

subsoil is about 21 inches thick. It is friable. The upper part is grayish brown silty clay loam. The lower part is pale yellow, calcareous silt loam. The underlying material to a depth of 60 inches is light gray, white, and light olive brown, calcareous silt loam varved with very fine sandy loam and silty clay. In some places the soil is dark to a depth of more than 16 inches. In other places it has less clay and more silt and very fine sand.

Typically, the surface layer of the Zell soil is dark gray, calcareous silt loam about 6 inches thick. Below this is a mixed layer of grayish brown, calcareous silt loam about 5 inches thick. The subsoil is light brownish gray, friable, calcareous silt loam about 7 inches thick. The underlying material to a depth of 60 inches is light gray and pale yellow, calcareous, varved silt loam.

Included with these soils in mapping are small areas of Bearden and Huffton soils. These included soils make up less than 10 percent of this map unit. The somewhat poorly drained Bearden soils are on toe slopes. Huffton soils have nests of salt and gypsum at or near the surface. They are in positions on the landscape similar to those of the Zell soil.

The content of organic matter is moderate in the Great Bend and Zell soils. Fertility is medium in the Great Bend soil and low or medium in the Zell soil. Permeability is moderate in the subsoil of the Great Bend soil and moderate to slow in the underlying material. It is moderate in the Zell soil. Available water capacity is high in both soils. Runoff is medium. The shrink-swell potential is moderate in the subsoil of the Great Bend soil and low in the underlying material. It is low in the Zell soil.

Most of the acreage is cultivated. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, barley, and oats are the main crops. A high content of lime in the surface layer of the Zell soil restricts the availability of plant nutrients. Controlling erosion and conserving moisture are the main management concerns. Increasing the organic matter content and improving fertility are additional concerns in areas of the Zell soil. Minimizing tillage and leaving crop residue on the surface help to control erosion, conserve moisture, and improve fertility. Where the slopes are suitable, contour farming, terraces, and grassed waterways help to control erosion.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

The Great Bend soil is suited to windbreaks and environmental plantings. Except for the species that require an abundant supply of moisture, all climatically suited trees and shrubs grow well on this soil. The Zell soil is suited to windbreaks and environmental plantings, but the high content of lime limits the available water capacity and the availability of plant nutrients. Selected trees and shrubs can be established on this soil, but optimum survival, growth, and vigor are unlikely.

These soils are suited to building site development. They are suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Great Bend soil is in capability unit IIe-1, Silty range site, and windbreak suitability group 3; the Zell soil is in capability unit IVe-2, Thin Upland range site, and windbreak suitability group 8.

GyC—Great Bend-Zell silt loams, 4 to 9 percent slopes. These deep, well drained, gently sloping and moderately sloping soils are on glacial lake plains. The Great Bend soil is on back slopes, and the Zell soil is on shoulder slopes. Areas are elongated or irregularly shaped and range from 5 to 50 acres in size. They are 60 to 70 percent Great Bend soil and 20 to 30 percent Zell soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Great Bend soil is grayish brown silt loam about 8 inches thick. The subsoil is about 21 inches thick. It is friable. The upper part is grayish brown silty clay loam. The lower part is pale yellow, calcareous silt loam. The underlying material to a depth of 60 inches is light gray, white, and light olive brown, calcareous silt loam varved with very fine sandy loam and silty clay. In some places the soil is dark to a depth of more than 16 inches. In other places it has less clay and more silt and very fine sand.

Typically, the surface layer of the Zell soil is dark gray, calcareous silt loam about 6 inches thick. Below this is a mixed layer of grayish brown, calcareous silt loam about 5 inches thick. The subsoil is light brownish gray, friable, calcareous silt loam about 7 inches thick. The underlying material to a depth of 60 inches is light gray and pale yellow, calcareous, varved silt loam.

Included with these soils in mapping are small areas of Bearden and Huffton soils. These included soils make up less than 10 percent of this map unit. The somewhat poorly drained Bearden soils are on toe slopes. Huffton soils have nests of salt and gypsum at or near the surface. They are in positions on the landscape similar to those of the Zell soil.

The content of organic matter is moderate in the

Great Bend and Zell soils. Fertility is medium in the Great Bend soil and low or medium in the Zell soil. Permeability is moderate in the subsoil of the Great Bend soil and moderate to slow in the underlying material. It is moderate in the Zell soil. Available water capacity is high in both soils. Runoff is medium. The shrink-swell potential is moderate in the subsoil of the Great Bend soil and low in the underlying material. It is low in the Zell soil.

Most of the acreage is cultivated. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, barley, and oats are the main crops. A high content of lime in the surface layer of the Zell soil restricts the availability of plant nutrients. Controlling erosion and conserving moisture are the main management needs. Increasing the organic matter content and improving fertility are additional concerns in areas of the Zell soil. Minimizing tillage, leaving crop residue on the surface, and planting close-growing crops help to control erosion, conserve moisture, and improve fertility. Where the slopes are suitable, contour farming, terraces, and grassed waterways help to control erosion.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

The Great Bend soil is suited to windbreaks and environmental plantings. Except for the species that require an abundant supply of moisture, all climatically suited trees and shrubs grow well on this soil. The Zell soil is suited to windbreaks and environmental plantings, but the high content of lime limits the available water capacity and the availability of plant nutrients. Selected trees and shrubs can be established on this soil, but optimum survival, growth, and vigor are unlikely. Where possible, planting on the contour helps to control erosion.

These soils are suited to building site development, but the slope is a limitation. Buildings should be designed so that they conform to the natural slope of the land.

These soils are suited to septic tank absorption fields, but the restricted permeability and the slope are limitations. Enlarging the absorption area helps to overcome a slow absorption rate. Land shaping and installing the distribution lines across the slope generally improve the efficiency of the absorption field.

The Great Bend soil is in capability unit IIIe-1, Silty range site, and windbreak suitability group 3; the Zell soil is in capability unit IVe-3, Thin Upland range site, and windbreak suitability group 8.

GzC—Great Bend-Zell-Huffton silt loams, 4 to 9 percent slopes. These deep, well drained, gently sloping and moderately sloping soils are on glacial lake plains. The Great Bend soil is on back slopes, and the Zell and Huffton soils are on shoulder slopes. Areas are elongated or irregularly shaped and range from 5 to 50 acres in size. They are 30 to 40 percent Great Bend soil, 25 to 35 percent Zell soil, and 15 to 25 percent Huffton soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Great Bend soil is grayish brown silt loam about 8 inches thick. The subsoil is about 21 inches thick. It is friable. The upper part is grayish brown silty clay loam. The lower part is pale yellow, calcareous silt loam. The underlying material to a depth of 60 inches is light gray, white, and light olive brown, calcareous silt loam varved with very fine sandy loam and silty clay. In some places the soil is dark to a depth of more than 16 inches. In other places it has less clay and more silt and very fine sand.

Typically, the surface layer of the Zell soil is dark gray, calcareous silt loam about 6 inches thick. Below this is a mixed layer of grayish brown, calcareous silt loam about 5 inches thick. The subsoil is light brownish gray, friable, calcareous silt loam about 7 inches thick. The underlying material to a depth of 60 inches is light gray and pale yellow, calcareous, varved silt loam.

Typically, the surface layer of the Huffton soil is dark grayish brown, calcareous silt loam about 7 inches thick. The subsoil is calcareous, very friable silt loam about 23 inches thick. The upper part is grayish brown and light gray. The lower part is light gray and pale yellow and has nests of gypsum and other salts. The underlying material to a depth of 60 inches is pale yellow and light gray, calcareous silt loam.

Included with these soils in mapping are small areas of Bearden and Beotia soils. These included soils make up less than 15 percent of this map unit. The somewhat poorly drained Bearden soils are on the lower toe slopes. Beotia soils are dark to a depth of more than 16 inches. They are on foot slopes.

The content of organic matter is moderate in the Great Bend, Zell, and Huffton soils. Fertility is medium in the Great Bend soil, low or medium in the Zell soil, and low in the Huffton soil. Permeability is moderate in the subsoil of the Great Bend and Huffton soils and moderate to slow in the underlying material. It is moderate in the Zell soil. Available water capacity is high in the Great Bend and Zell soils and moderate in the Huffton soil. Runoff is medium on all three soils. The shrink-swell potential is moderate in the subsoil of the Great Bend soil and low in the underlying material. It is low in the Zell and Huffton soils.

Most of the acreage is cultivated. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, barley, and oats are the main crops. A high content of lime in the surface layer of the Zell and Huffton soils and high salinity in the Huffton soil increase the susceptibility to wind erosion, restrict the availability of plant nutrients, and decrease the available water capacity. Controlling erosion and conserving moisture are the main management needs. Increasing the organic matter content and improving fertility are additional concerns in areas of the Zell and Huffton soils. Minimizing tillage, leaving crop residue on the surface, and planting close-growing crops help to control erosion, conserve moisture, and improve fertility. Where the slopes are suitable, contour farming, terraces, and grassed waterways help to control erosion.

No major hazards or limitations affect the use of the Great Bend and Zell soils for range. The high salinity in the Huffton soil limits the choice of species and restricts plant growth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

The Great Bend soil is suited to windbreaks and environmental plantings. Except for the species that require an abundant supply of moisture, all climatically suited trees and shrubs grow well on this soil. The Zell and Huffton soils are suited to windbreaks and environmental plantings, but the high content of lime limits the available water capacity and the availability of plant nutrients. Also, the high content of salts in the root zone of the Huffton soil limits the selection of adapted species. Selected trees and shrubs can be established, but optimum survival, growth, and vigor are unlikely. Where possible, planting on the contour helps to control erosion.

The Great Bend, Zell, and Huffton soils are suited to building site development, but the slope is a limitation. Buildings should be designed so that they conform to the natural slope of the land.

These soils are suited to septic tank absorption fields, but the restricted permeability and the slope are limitations. Enlarging the absorption area helps to overcome a slow absorption rate. Land shaping and installing the distribution lines across the slope generally improve the efficiency of the absorption field.

The Great Bend soil is in capability unit IIIe-1, Silty range site, and windbreak suitability group 3; the Zell soil is in capability unit IVe-3, Thin Upland range site, and windbreak suitability group 8; the Huffton soil is in capability unit IVe-3, Thin Upland range site, and windbreak suitability group 8.

Ha—Hamar loamy fine sand. This deep, somewhat poorly drained, level and nearly level soil is on glacial lake plains. Areas are irregular in shape and range from 5 to 75 acres in size. Slopes are concave or plane.

Typically, the surface layer is dark gray loamy fine sand about 7 inches thick. The subsurface layer is dark gray, mottled loamy fine sand about 10 inches thick. The underlying material to a depth of 60 inches is grayish brown, mottled fine sand. It is calcareous in the lower part. In some areas the soil has silty underlying material within a depth of 40 inches.

Included with this soil in mapping are small areas of Arveson, Fossum, Hecla, and Ulen soils. These soils make up less than 15 percent of this map unit. Arveson, Fossum, and Ulen soils have free lime at the surface. Arveson soils contain more silt and less sand than the Hamar soil. Arveson and Fossum soils are on the slightly lower parts of the landscape. The moderately well drained and somewhat poorly drained Ulen soils are on toe slopes around areas of the Hamar soil. The moderately well drained Hecla soils are in the higher positions on the landscape.

The content of organic matter is moderate in the Hamar soil, and fertility is medium. Permeability is moderately rapid or rapid. Available water capacity is low or moderate. The water table is within a depth of 2 feet during wet periods. Runoff is slow. The shrink-swell potential is low.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are Garrison creeping foxtail, reed canarygrass, intermediate wheatgrass, and smooth brome. Wheat, corn, and oats are the main crops. The hazard of wind erosion is severe. Wetness frequently reduces crop yields and commonly delays spring planting, tillage, or harvesting. Measures that reduce wetness, control wind erosion, and maintain fertility are the main management needs. Tillage practices that leave crop residue on the surface, minimum tillage, field windbreaks, stripcropping, and a cropping sequence that includes grasses and legumes help to control erosion, conserve moisture, and help to maintain fertility.

If this soil is used for range, wind erosion can be a problem unless an adequate plant cover is maintained. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain productivity and an adequate plant cover. The risk of blowouts increases along overused livestock trails and around watering facilities.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on this soil, and those that require an abundant supply of moisture grow especially well. Planting after

minimal site preparation helps to control wind erosion.

This soil is generally unsuited to building site development and septic tank absorption fields because of the wetness.

This soil is in capability unit IVw-2, Subirrigated range site, and windbreak suitability group 2S.

Hc—Hamerly loam. This deep, somewhat poorly drained, level and nearly level soil is on till plains. Areas are irregular in shape and range from 5 to 70 acres in size. Slopes are smooth or slightly concave.

Typically, the surface layer is dark gray, calcareous loam about 17 inches thick. The subsoil is about 17 inches thick. It is friable and calcareous. It is light gray loam in the upper part and light brownish gray clay loam in the lower part. The underlying material to a depth of 60 inches is light yellowish brown, calcareous clay loam.

Included with this soil in mapping are small areas of Barnes, Bowbells, Svea, Tonka, Vallers, and Williams soils. These soils make up less than 15 percent of this map unit. The moderately well drained Bowbells and Svea soils and the well drained Barnes and Williams soils are on the higher parts of the landscape. The poorly drained Tonka soils are in basins. The poorly drained Vallers soils are on the slightly lower parts of the landscape.

The content of organic matter is high in the Hamerly soil, and fertility is medium. Permeability is moderate in the upper part of the profile and moderately slow in the lower part. Available water capacity is high. The water table is at a depth of 2 to 4 feet during wet periods. Runoff is slow. The shrink-swell potential is moderate.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, barley, and oats are the main crops. A high content of lime in the surface layer restricts the availability of plant nutrients and increases the susceptibility to wind erosion. Measures that control wind erosion are the main management needs. Examples are tillage practices that leave crop residue on the surface and stripcropping.

No major hazards or limitations affect the use of this soil for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, especially those that require an abundant supply of moisture.

This soil is generally unsuited to most kinds of building site development and septic tank absorption fields because of the wetness.

This soil is in capability unit IIe-4, Limy Subirrigated range site, and windbreak suitability group 1.

Hd—Hamerly loam, saline. This deep, somewhat poorly drained, level and nearly level soil is on till plains. Areas are irregular in shape and range from 5 to 70 acres in size. Slopes are smooth or slightly concave.

Typically, the surface layer is dark gray, calcareous loam about 7 inches thick. The subsurface layer also is dark gray, calcareous loam. It is about 5 inches thick. The subsoil is light brownish gray, friable, calcareous loam and clay loam about 11 inches thick. The underlying material to a depth of 60 inches is light olive brown, calcareous clay loam. The soil has nests and seams of gypsum and other salts to a depth of 40 inches.

Included with this soil in mapping are small areas of Barnes, Svea, Tonka, and Vallers soils. These soils make up less than 15 percent of this map unit. The well drained Barnes and moderately well drained Svea soils are higher on the landscape than the Hamerly soil. The poorly drained Tonka soils are in basins. The poorly drained Vallers soils are in the slightly lower positions on the landscape.

The content of organic matter is high in the Hamerly soil, and fertility is low. Permeability is moderate in the upper part of the profile and moderately slow in the lower part. Available water capacity is moderate. The water table is at a depth of 2 to 4 feet during wet periods. Runoff is slow. The shrink-swell potential is moderate.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are tall wheatgrass, switchgrass, and western wheatgrass. Barley is the main crop. The high content of salts is a limitation. A high content of lime in the surface layer restricts the availability of plant nutrients and increases the susceptibility to wind erosion. Measures that control wind erosion and improve fertility are the main management needs. Examples are tillage practices that leave crop residue on the surface and stripcropping.

Some areas support native grasses and are used for grazing. The salinity limits productivity and the variety of suitable grasses. Proper stocking rates and timely deferment of grazing help to maintain maximum productivity.

This soil is generally unsuited to windbreaks and environmental plantings because of the high content of salts.

This soil is generally unsuited to most kinds of

building site development and septic tank absorption fields because of the wetness.

This soil is in capability unit IIIs-6, Saline Subirrigated range site, and windbreak suitability group 10.

Hf—Hamerly-Tonka complex. These deep, level and nearly level soils are on till plains. The somewhat poorly drained Hamerly soil is on the upper toe slopes around and between the basins. The poorly drained Tonka soil is in basins. The Tonka soil is ponded during spring runoff and after heavy rains. Areas are irregular in shape and range from 5 to 50 acres in size. They are 45 to 55 percent Hamerly soil and 30 to 40 percent Tonka soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Hamerly soil is dark gray, calcareous loam about 7 inches thick. The subsoil is about 17 inches thick. It is friable and calcareous. It is light gray loam in the upper part and light brownish gray clay loam in the lower part. The underlying material to a depth of 60 inches is light yellowish brown, calcareous clay loam.

Typically, the surface layer of the Tonka soil is gray silt loam about 9 inches thick. The subsurface layer is light gray silt loam about 9 inches thick. The subsoil is about 32 inches thick. It is firm. It is gray silty clay in the upper part and light brownish gray and light gray silty clay loam in the lower part. The underlying material to a depth of 60 inches is light gray, calcareous silty clay loam.

Included with these soils in mapping are small areas of Barnes, Nishon, Svea, and Vallers soils. These included soils make up less than 15 percent of this map unit. The well drained Barnes soils are on back slopes. Nishon soils have a surface layer that is thinner than that of the Tonka soil. They are in positions on the landscape similar to those of the Tonka soil. The poorly drained Vallers soils are slightly lower on the landscape than the Hamerly soil. Svea soils are dark to a depth of more than 16 inches. They are in the slightly higher positions on the landscape.

The content of organic matter is high in the Hamerly and Tonka soils. Fertility is medium in the Hamerly soil and high in the Tonka soil. Permeability is moderate in the subsoil of the Hamerly soil and moderately slow in the underlying material. It is slow in the Tonka soil. Available water capacity is high in both soils. During wet periods, the water table in the Hamerly soil is at a depth of 2 to 4 feet and that in the Tonka soil is within a depth of 1 foot. As much as 0.5 foot of water may pond on the Tonka soil. Runoff is slow on the Hamerly soil and ponded on the Tonka soil. The shrink-swell potential is moderate in the Hamerly soil and high in the Tonka soil.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants on the Hamerly soil are alfalfa, intermediate wheatgrass, and smooth brome. On the Tonka soil the choice of pasture plants is limited to water-tolerant species, such as Garrison creeping foxtail and reed canarygrass. Wheat and barley are the main crops. A high content of lime in the surface layer restricts the availability of plant nutrients and increases the susceptibility to wind erosion. Wind erosion on the Hamerly soil and the ponding on the Tonka soil are the main management concerns. Wetness also is a concern on the Hamerly soil in some years. Tillage practices that leave crop residue on the surface help to control erosion and improve fertility. Stripcropping reduces the susceptibility to wind erosion. In most years planting is delayed on the Tonka soil because of the ponding. Surface drains help to remove the excess water.

No major hazards or limitations affect the use of the Hamerly soil for range. Surface compaction is a problem on the Tonka soil during wet periods. Restricted grazing during these periods helps to prevent compaction. Many areas of the Tonka soil are potential sites for excavated ponds.

The Hamerly soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well. The Tonka soil is generally unsuited to windbreaks and environmental plantings unless it is drained.

These soils are generally unsuited to most kinds of building site development and septic tank absorption fields because of the wetness.

The Hamerly soil is in capability unit IIe-4, Limy Subirrigated range site, and windbreak suitability group 1; the Tonka soil is in capability unit IVw-1, Wet Meadow range site, and windbreak suitability group 10.

Hh—Hamerly-Vallers loams. These deep, level and gently undulating soils are on till plains. Slopes are 0 to 3 percent. The somewhat poorly drained Hamerly soil is on the upper toe slopes, and the poorly drained Vallers soil is on the lower toe slopes. The Vallers soil is subject to rare flooding. Scattered stones are on the surface in some areas. Areas are long and narrow or irregularly shaped and range from 5 to 100 acres in size. They are 40 to 50 percent Hamerly soil and 35 to 45 percent Vallers soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Hamerly soil is

dark gray, calcareous loam about 7 inches thick. The subsoil is about 17 inches thick. It is friable and calcareous. It is light gray loam in the upper part and light brownish gray clay loam in the lower part. The underlying material to a depth of 60 inches is light yellowish brown, calcareous clay loam.

Typically, the surface layer of the Vallers soil is very dark gray, calcareous loam about 10 inches thick. The subsoil is light gray, friable, calcareous clay loam about 13 inches thick. The underlying material to a depth of 60 inches is calcareous clay loam. It is light olive gray in the upper part and light olive gray and light gray in the lower part.

Included with these soils in mapping are small areas of Heil, Nishon, and Tonka soils. These included soils make up less than 15 percent of this map unit. They do not have free lime within a depth of 16 inches. They are in basins.

The content of organic matter is high in the Hamerly and Vallers soils, and fertility is medium. Permeability is moderate in the upper part of the Hamerly soil and moderately slow in the lower part. It is moderately slow in the Vallers soil. Available water capacity is high in both soils. During wet periods the water table is at a depth of 2.0 to 4.0 feet in the Hamerly soil and 1.0 to 2.5 feet in the Vallers soil. Runoff is slow on both soils. The shrink-swell potential is moderate in the Hamerly soil. It is moderate in the subsoil of the Vallers soil and low in the underlying material.

About half of the acreage supports native grasses and is used for grazing. Deferring grazing during wet periods helps to prevent the soil from becoming compacted.

These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants on the Hamerly soil are alfalfa, intermediate wheatgrass, and smooth brome. On the Vallers soil the choice of suitable pasture plants is limited to water-tolerant species, such as Garrison creeping foxtail and reed canarygrass. Wheat, barley, and rye are the main crops. A high content of lime in the surface layer of both soils and the flooding on the Vallers soil are limitations. Planting or harvesting may be delayed during wet periods. The high content of lime limits the availability of plant nutrients and increases the susceptibility to wind erosion. Measures that control wind erosion are the main management needs. Tillage practices that leave crop residue on the surface, a cropping sequence that includes grasses and legumes, and timely tillage help to control wind erosion and improve fertility.

Windbreaks and environmental plantings should be established on the Hamerly soil rather than on the Vallers soil. All climatically suited trees and shrubs grow well on the Hamerly soil, especially those that require an abundant supply of moisture. The Vallers soil is generally unsuited to windbreaks and environmental plantings because of the wetness and the flooding.

These soils are generally unsuited to building site development and septic tank absorption fields because of the wetness and because of the flooding on the Vallers soil.

The Hamerly soil is in capability unit IIe-4, Limy Subirrigated range site, and windbreak suitability group 1; the Vallers soil is in capability unit IVw-3, Subirrigated range site, and windbreak suitability group 10.

Hm—Harmony Variant clay loam. This moderately well drained, level and nearly level soil is on outwash plains. It is moderately deep over sand. Areas are irregular in shape and range from 20 to 150 acres in size. Slopes are smooth.

Typically, the surface layer is dark gray clay loam about 8 inches thick. The subsoil is about 22 inches thick. The upper part is dark gray and grayish brown, firm clay loam. The lower part is light gray, friable, calcareous loam. The underlying material to a depth of 60 inches is light brownish gray, calcareous loamy fine sand and fine sand.

Included with this soil in mapping are small areas of Aberdeen soils that have a sandy substratum and small areas of Spottswood soils. These soils make up less than 15 percent of this map unit. Aberdeen soils have a sodium-affected subsoil. They are in the slightly lower positions on the landscape. Spottswood soils contain less clay in the subsoil than the Harmony Variant soil. They are in positions on the landscape similar to those of the Harmony Variant soil.

The content of organic matter is high in the Harmony Variant soil. Fertility is medium. Tilth is fair. Permeability is moderate or moderately slow in the subsoil and rapid in the underlying material. Available water capacity is moderate. The water table is at a depth of 3 to 6 feet during wet periods. Runoff is slow. The shrink-swell potential is high in the subsoil and low in the underlying material.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, barley, and oats are the main crops. Measures that improve tilth and conserve moisture are the main management needs. Leaving crop residue on the surface and including grasses and legumes in the cropping sequence are examples.

No major hazards or limitations affect the use of this soil for range. Proper stocking rates, timely deferment

of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to windbreaks and environmental plantings. It takes in water slowly, however, and the clayey subsoil can restrict the penetration of plant roots. Windbreaks can be established, but optimum growth is unlikely.

This soil is suited to building site development, but the wetness is a limitation. Installing foundation drains and diverting runoff away from the buildings help to prevent the structural damage caused by wetness.

This soil is generally unsuited to septic tank absorption fields because of the wetness and a poor filtering capacity. The poor filtering capacity may result in the pollution of ground water.

This soil is in capability unit IIs-1, Clayey range site, and windbreak suitability group 4L.

Hn—Harmony-Aberdeen silty clay loams. These deep, level and nearly level, moderately well drained soils are on glacial lake plains. The Harmony soil is on the upper foot slopes, and the Aberdeen soil is on the lower foot slopes. Areas are irregular in shape and range from 20 to more than 500 acres in size. They are 50 to 60 percent Harmony soil and 25 to 35 percent Aberdeen soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Harmony soil is dark gray silty clay loam about 8 inches thick. The subsurface layer also is dark gray silty clay loam. It is about 7 inches thick. The subsoil is about 25 inches thick. The upper part is dark gray, friable silty clay loam. The next part is grayish brown and light brownish gray, firm silty clay. The lower part is light brownish gray, calcareous clay loam. The underlying material to a depth of 60 inches is light gray, calcareous loam that is varved with thin layers of silty clay and very fine sandy loam.

Typically, the surface layer of the Aberdeen soil is dark gray silty clay loam about 8 inches thick. Below this is a transitional layer of gray and very dark gray silty clay loam about 3 inches thick. The subsoil is about 27 inches thick. It is firm. The upper part is dark gray silty clay. The lower part is light gray and light brownish gray, calcareous silty clay loam that has nests of gypsum and other salts. The upper part of the underlying material is light gray, calcareous silt loam that has nests of gypsum. The lower part to a depth of 60 inches is pale yellow, calcareous silt loam varved with silty clay and very fine sandy loam.

Included with these soils in mapping are small areas of Beotia, Exline, and Nahon soils. These included soils make up less than 15 percent of this map unit. Beotia soils contain less clay and more silt in the subsoil than the Harmony and Aberdeen soils. They are in positions on the landscape similar to those of the Harmony soil. Exline and Nahon soils have a subsoil that is more dense and more restrictive than that of the Harmony and Aberdeen soils. Also, they are in slightly lower positions on the landscape.

The content of organic matter is high in the Harmony soil and moderate in the Aberdeen soil. Fertility is high in the Harmony soil and medium in the Aberdeen soil. The Aberdeen soil has a sodium-affected subsoil. Tilth is fair in both soils. Permeability is moderately slow in the subsoil of the Harmony soil and slow in the subsoil of the Aberdeen soil. It is moderate to slow in the underlying material of both soils. Available water capacity is high in the Harmony soil and moderate or high in the Aberdeen soil. During wet periods the water table is at a depth of 4 to 6 feet in the Aberdeen soil. Runoff is slow on both soils. The shrink-swell potential is high in the subsoil and low in the underlying material.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, oats, soybeans, and sunflowers are the main crops. The Harmony soil has a clayey subsoil that takes in water slowly and releases it slowly to plants. The Aberdeen soil has a sodium-affected subsoil that limits root development and the availability of plant nutrients. Improving tilth and conserving moisture are the main management needs in cultivated areas. Tillage practices that leave crop residue on the surface, chiseling or subsoiling, and a cropping sequence that includes grasses and legumes help to maintain or improve tilth and fertility and conserve moisture.

If these soils are used for range, compaction can be a problem during wet periods. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth.

These soils are suited to windbreaks and environmental plantings. The clayey subsoil takes in water slowly and can restrict the penetration of plant roots. Windbreaks can be established, but optimum growth is unlikely.

These soils are suited to building site development, but the high shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are suited to septic tank absorption

fields, but the restricted permeability is a limitation. The varves in the underlying material result in the slow absorption of liquid waste. Enlarging the absorption area helps to overcome the slow absorption rate.

The Harmony soil is in capability unit IIs-1, Clayey range site, and windbreak suitability group 4L; the Aberdeen soil is in capability unit IIIs-1, Clayey range site, and windbreak suitability group 4L.

Hp—Harmony-Beotia silt loams. These deep, level and nearly level soils are on foot slopes on glacial lake plains. The Harmony soil is moderately well drained, and the Beotia soil is well drained. The Beotia soil is slightly higher on the foot slopes than the Harmony soil. Areas are irregular in shape and range from 20 to 300 acres in size. They are 50 to 60 percent Harmony soil and 25 to 35 percent Beotia soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Harmony soil is dark gray silt loam about 8 inches thick. The subsurface layer is dark gray silty clay loam about 7 inches thick. The subsoil is about 25 inches thick. The upper part is dark gray, friable silty clay loam. The next part is grayish brown and light brownish gray, firm silty clay. The lower part is light brownish gray, calcareous clay loam. The underlying material to a depth of 60 inches is light gray, calcareous loam that is varved with silty clay and very fine sandy loam.

Typically, the surface layer of the Beotia soil is dark gray silt loam about 11 inches thick. The subsoil is about 31 inches thick. It is friable. The upper part is grayish brown silty clay loam and silt loam. The lower part is pale yellow, calcareous silt loam. The underlying material to a depth of 60 inches is pale yellow, calcareous silt loam varved with very fine sandy loam and silty clay. In places the soil is dark to a depth of less than 16 inches.

Included with these soils in mapping are small areas of Aberdeen, Bearden, and Winship soils. These included soils make up less than 15 percent of this map unit. Aberdeen soils have a sodium-affected subsoil. They are slightly lower on the landscape than the Harmony soil. The somewhat poorly drained Bearden and Winship soils are on toe slopes. Bearden soils have free lime within a depth of 16 inches.

The content of organic matter is high in the Harmony and Beotia soils. Fertility also is high. Tilth is fair in the Harmony soil and good in the Beotia soil. Available water capacity is high in both soils. Permeability is moderately slow in the subsoil of the Harmony soil and moderate in the subsoil of the Beotia soil. It is moderate to slow in the underlying material of both soils. Runoff is slow on both soils. The shrink-swell potential is high in the subsoil of the Harmony soil and moderate in the subsoil of the Beotia soil. It is low in the underlying material of both soils.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, oats, sunflowers, and soybeans are the main crops. Measures that improve tilth in the Harmony soil and conserve moisture in both soils are the main management needs. Examples are leaving crop residue on the surface and including grasses and legumes in the cropping sequence.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

The Harmony soil is suited to windbreaks and environmental plantings. It takes in water slowly, however, and the clayey subsoil can restrict the penetration of plant roots. Windbreaks can be established, but optimum growth is unlikely. The Beotia soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, except for those that require an abundant supply of moisture.

These soils are suited to building site development, but the high or moderate shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. The varves in the underlying material result in the slow absorption of liquid waste. Enlarging the absorption area helps to overcome the slow absorption rate.

The Harmony soil is in capability unit IIs-1, Clayey range site, and windbreak suitability group 4L; the Beotia soil is in capability unit IIc-3, Silty range site, and windbreak suitability group 3.

Hr—Harriet loam. This deep, poorly drained, level soil is on flood plains. It is occasionally flooded for long periods. Areas are irregular in shape and range from 5 to more than 300 acres in size. Slopes are concave or smooth.

Typically, the surface layer is gray loam about 2 inches thick. The subsoil is dark gray and gray, calcareous clay loam about 24 inches thick. It is very firm in the upper part and firm in the lower part and has crystals and nests of salt throughout. The underlying material to a depth of 60 inches is gray, calcareous clay

loam. In places the subsoil does not have columnar structure.

Included with this soil in mapping are small areas of the somewhat poorly drained Ranslo soils on the higher flood plains. These soils make up less than 10 percent of this map unit.

The content of organic matter is moderate in the Harriet soil, and fertility is low or medium. This soil has a sodium-affected subsoil. Permeability is very slow. Available water capacity is moderate. The water table is within a depth of 1 foot during wet periods. Runoff is slow. The shrink-swell potential is high.

Nearly all of the acreage supports native grasses and is used for grazing. Surface compaction is a problem. Grazing when the soil is wet causes surface compaction and puddling, both of which result in an increase in the extent of the less desirable grasses and of weeds. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is generally unsuited to cultivated crops and to windbreaks and environmental plantings because of the wetness and the high concentration of salts in the subsoil.

This soil is suited to tame pasture and hay, but the choice of pasture plants is limited because of the high salinity. The best suited pasture plants are tall wheatgrass and western wheatgrass.

This soil is generally not suited to building site development and septic tank absorption fields because of the wetness and the flooding.

This soil is in capability unit VIs-6, Saline Lowland range site, and windbreak suitability group 10.

HtB—Hecla-Hamar loamy fine sands, 0 to 6 percent slopes. These deep, level to gently sloping soils are on sandy glacial lake plains. The moderately well drained Hecla soil is on foot slopes, and the somewhat poorly drained Hamar soil is in basins. Areas are irregular in shape and range from 10 to 700 acres in size. They are 45 to 60 percent Hecla soil and 25 to 40 percent Hamar soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Hecla soil is dark gray loamy fine sand about 6 inches thick. The subsurface layer is dark gray fine sand about 14 inches thick. The next layer also is dark gray fine sand. It is about 10 inches thick. The underlying material extends to a depth of about 54 inches. It is grayish brown fine sand. Below this to a depth of 60 inches is very dark gray fine sandy loam. In some areas the soil has silty underlying material within a depth of 40 inches.

Typically, the surface layer of the Hamar soil is dark gray loamy fine sand about 7 inches thick. The subsurface layer is mottled, dark gray loamy fine sand about 10 inches thick. The underlying material to a depth of 60 inches is grayish brown, mottled fine sand. It is calcareous in the lower part. In some areas the soil has silty underlying material within a depth of 40 inches.

Included with these soils in mapping are small areas of Arveson, Fossum, Maddock, and Ulen soils. These included soils make up less than 20 percent of this map unit. Arveson, Fossum, and Ulen soils have free lime at the surface. Arveson and Fossum soils are in positions on the landscape similar to those of the Hamar soil. Ulen soils are on toe slopes adjacent to the basins. Arveson soils contain more silt and clay than the Hecla and Hamar soils. Fossum soils are poorly drained and very poorly drained. The well drained Maddock soils are on back slopes.

The content of organic matter is moderate in the Hecla and Hamar soils, and fertility is medium. Permeability is moderately rapid or rapid. Available water capacity is low or moderate. During wet periods, the Hecla soil has a water table at a depth of 3 to 6 feet and the Hamar soil has one within a depth of 2 feet. Runoff is slow on both soils. The shrink-swell potential is low.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay, but the hazard of wind erosion is severe. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, and oats are the main crops. Wetness frequently reduces crop yields and commonly delays spring planting, tillage, or harvesting on the Hamar soil. Measures that control wind erosion on both soils and the wetness in the Hamar soil are the main management needs. Improving fertility, increasing the content of organic matter, and conserving moisture are additional concerns. Stripcropping, tillage practices that leave crop residue on the surface, minimum tillage, and field windbreaks help to control wind erosion, conserve moisture, and increase the content of organic matter.

If these soils are used for range, wind erosion is a hazard unless an adequate plant cover is maintained. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain productivity and an adequate plant cover. The risk of blowouts increases along overused livestock trails and around watering facilities.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, and those that require an abundant supply of moisture grow especially well. Planting after minimal site preparation helps to control wind erosion.

The Hecla soil is suited to building site development, but the wetness is a limitation. Installing foundation

drains reduces the wetness. The sides of shallow excavations tend to cave in unless they are shored. The Hamar soil is generally unsuited to building site development because of the wetness.

These soils are generally unsuited to septic tank absorption fields because of the wetness and a poor filtering capacity. The poor filtering capacity can result in the pollution of ground water.

The Hecla soil is in capability unit IVe-10, Sandy range site, and windbreak suitability group 1; the Hamar soil is in capability unit IVw-2, Subirrigated range site, and windbreak suitability group 2S.

Hx—Heil silt loam. This deep, poorly drained, level soil is on till plains. It is ponded during periods of snowmelt and after heavy rains. In places scattered stones are on the surface and in the soil. Areas are circular or irregularly shaped and range from 5 to 100 acres in size. Slopes are concave.

Typically, the surface layer is gray silt loam about 2 inches thick. The subsoil is dark gray, very firm silty clay about 33 inches thick. The lower part has nests of salt. The underlying material to a depth of 60 inches is gray and light gray, calcareous clay loam. It has nests of salt.

Included with this soil in mapping are small areas of Nishon and Tonka soils. These soils make up less than 5 percent of this map unit. They are in the lower part of the basins. They do not have a sodium-affected subsoil. They have a surface layer that is thicker than that of the Heil soil.

The content of organic matter is moderate in the Heil soil, and fertility is medium. This soil has a dense, sodium-affected subsoil. Permeability is very slow. Available water capacity is moderate. A seasonal high water table is within a depth of 1 foot most of the year. As much as 1 foot of water ponds on the surface during some wet periods. Runoff is ponded. The shrink-swell potential is high.

Most of the acreage supports native grasses and is used for grazing or hay. Many small areas are farmed along with the adjacent areas. Surface compaction is a problem during wet periods. Restricted grazing during these periods helps to prevent compaction and puddling, both of which result in an increase in the extent of the less desirable grasses and of weeds. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is generally unsuited to cultivated crops and to windbreaks and environmental plantings. The dense, compact subsoil and the ponding are the main limitations.

This soil is suited to tame pasture and hay, but the choice of tame pasture plants is limited because natural drainage is restricted and artificial drainage generally is not feasible. Examples of suitable pasture plants are Garrison creeping foxtail and western wheatgrass.

This soil is generally unsuited to building site development and septic tank absorption fields because of the ponding.

This soil is in capability unit VIs-6, Closed Depression range site, and windbreak suitability group 10.

Ka—Koto loam. This deep, poorly drained, level soil is on till plains. It is occasionally flooded for brief to long periods. Areas are irregular in shape and range from 5 to 60 acres in size.

Typically, the surface layer of the Koto soil is dark gray loam about 8 inches thick. The subsurface layer is light gray sandy loam about 3 inches thick. The subsoil is about 31 inches thick. The upper part is grayish brown, very friable and friable sandy clay loam. The next part is light brownish gray, mottled, very friable, calcareous loam. The lower part is light gray, mottled, very friable, calcareous sandy loam. The underlying material to a depth of 60 inches is light gray and light yellowish brown, calcareous loam. In places the soil contains more sand.

Included with this soil in mapping are small areas of Hamerly, Letcher, Nishon, and Tonka soils. These soils make up less than 15 percent of this map unit. The somewhat poorly drained Hamerly and Letcher soils are on toe slopes. Letcher soils have a sodium-affected subsoil. Nishon and Tonka soils contain more clay and less sand than the Koto soil. They are in positions on the landscape similar to those of the Koto soil.

The content of organic matter is moderate in the Koto soil, and fertility is medium. Permeability is slow. Available water capacity is moderate or high. The water table is at a depth of 1 to 3 feet early in spring and during other wet periods. Runoff is slow. The shrink-swell potential is moderate.

The Koto soil is poorly suited to cultivated crops and to tame pasture and hay. Crop growth is severely restricted because of the wetness. Garrison creeping foxtail, reed canarygrass, and tall wheatgrass are examples of suitable pasture plants. Wheat, corn, oats, and sunflowers are the main crops. The wetness commonly delays tillage in spring and during other wet periods. Surface drains help to remove the excess water.

If this soil is used for range, the wetness is a limitation. Suitable drainage outlets generally are not available. Grazing during wet periods causes surface compaction and puddling, both of which result in a decrease in the extent of desirable grasses. Proper stocking rates, timely deferment of grazing, and rotation

grazing help to maintain maximum productivity.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, especially those that require an abundant supply of moisture.

This soil is unsuited to building site development and sanitary facilities because of the wetness and the flooding.

This soil is in capability unit IVw-2, Subirrigated range site, and windbreak suitability group 2W.

Kh—Koto-Harriet loams. These deep, poorly drained, level soils are occasionally flooded for brief to long periods. The Koto soil is on toe slopes, and the Harriet soil is on the higher flood plains. Areas are irregular in shape and range from 10 to 60 acres in size. They are 55 to 65 percent Koto soil and 20 to 30 percent Harriet soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Koto soil is dark gray loam about 8 inches thick. The subsurface layer is light gray sandy loam about 3 inches thick. The subsoil is about 31 inches thick. The upper part is grayish brown, very friable and friable sandy clay loam. The next part is light brownish gray, mottled, very friable, calcareous loam. The lower part is light gray, mottled, very friable, calcareous sandy loam. The underlying material to a depth of 60 inches is light gray and light yellowish brown, calcareous loam. In places the soil contains more sand.

Typically, the surface layer of the Harriet soil is gray loam about 2 inches thick. The subsoil is dark gray and gray, calcareous clay loam about 24 inches thick. It is very firm in the upper part and firm in the lower part. It has nests of salt throughout. The underlying material to a depth of 60 inches is gray, calcareous clay loam.

Included with these soils in mapping are small areas of Letcher and Miranda soils on the upper toe slopes. These included soils make up less than 15 percent of this map unit. Letcher soils contain more sand than the Koto and Harriet soils, and the somewhat poorly drained Miranda soils contain less clay.

The content of organic matter is moderate in the Koto and Harriet soils. Fertility is medium in the Koto soil and low or medium in the Harriet soil. The Harriet soil has a sodium-affected subsoil. Tilth is fair in the Koto soil and poor in the Harriet soil. Permeability is slow in the Koto soil and very slow in the Harriet soil. Available water capacity is moderate or high in the Koto soil and moderate in the Harriet soil. Runoff is slow on both soils. During wet periods, the Koto soil has a water table at a depth of 1 to 3 feet and the Harriet soil has one within a depth of 1 foot. The shrink-swell potential is moderate in the Koto soil and high in the Harriet soil.

Most of the acreage supports native grasses and is used for grazing. The wetness is a limitation on both soils, and compaction is a major problem on the Harriet soil during wet periods. Grazing when the soils are wet causes surface compaction and puddling, both of which result in a decrease in the extent of desirable grasses. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are poorly suited to cultivated crops and to tame pasture and hay. Crop growth is severely restricted because of the wetness in both soils and the sodium-affected subsoil in the Harriet soil. Garrison creeping foxtail, reed canarygrass, tall wheatgrass, and western wheatgrass are examples of suitable pasture plants. Wheat, corn, oats, and barley are the main cultivated crops. The main management concerns are reducing wetness and improving tilth. Artificial drainage generally is not feasible. Leaving crop residue on the surface and including grasses and legumes in the cropping sequence improve tilth. Chiseling or subsoiling improves tilth and increases the rate of water intake for a short time.

The Koto soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, and those that require an abundant supply of moisture grow especially well. The Harriet soil is generally unsuited to windbreaks and environmental plantings because of the wetness and the sodium-affected subsoil.

These soils are generally unsuited to building site development and septic tank absorption fields because of the seasonal high water table, the flooding, and the high shrink-swell potential.

The Koto soil is in capability unit IVw-2, Subirrigated range site, and windbreak suitability group 2W; the Harriet soil is in capability unit VIs-6, Saline Lowland range site, and windbreak suitability group 10.

KkA—Kranzburg-Brookings silt loams, 0 to 2 percent slopes. These deep, level to undulating soils are on till plains. The well drained Kranzburg soil is on back slopes, and the moderately well drained Brookings soil is on foot slopes. Areas are irregular in shape and range from 15 to more than 500 acres in size. They are 40 to 55 percent Kranzburg soil and 30 to 45 percent Brookings soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Kranzburg soil is dark gray silt loam about 7 inches thick. The subsoil is about 29 inches thick. The upper part is dark grayish brown and brown, friable silt loam. The lower part is light brownish gray, firm, calcareous clay loam. The

underlying material to a depth of 60 inches is pale yellow and light gray, calcareous clay loam.

Typically, the surface layer of the Brookings soil is dark gray silt loam about 8 inches thick. The subsurface layer also is dark gray silt loam. It is about 6 inches thick. The subsoil is about 24 inches thick. The upper part is dark grayish brown and light olive brown, friable silt loam. The next part is light yellowish brown, friable, calcareous silt loam. The lower part is grayish brown, firm, calcareous clay loam. The underlying material to a depth of 60 inches is light brownish gray, calcareous clay loam. In places the clay loam glacial till is below a depth of 40 inches.

Included with these soils in mapping are small areas of Barnes, Buse, Cresbard, and Tonka soils. These included soils make up less than 15 percent of this map unit. Barnes soils contain more sand and less silt in the subsoil. They are in slightly higher positions on the landscape than the Kranzburg soil. Buse soils have lime at or near the surface. They are on shoulder slopes. Cresbard soils have a sodium-affected subsoil. They are slightly lower on the landscape than the Brookings soil. The poorly drained Tonka soils are in basins.

The content of organic matter is moderate in the Kranzburg soil and high in the Brookings soil. Fertility is medium in the Kranzburg soil and high in the Brookings soil. Permeability is moderate in the silty material of both soils and moderately slow in the underlying glacial till. Available water capacity is high. The Brookings soil has a water table at a depth of 3 to 6 feet during wet periods. Runoff is slow on both soils. The shrink-swell potential is moderate.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, oats, soybeans, and barley are the main crops (fig. 10). Because of runoff from the adjacent soils, planting and harvesting are delayed during some wet periods on the Brookings soil. The additional moisture is beneficial, however, in most years. Measures that conserve moisture are the main management needs in areas of the Kranzburg soil. Examples are tillage practices that leave crop residue on the surface.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Kranzburg soil, except for those that require an abundant supply of moisture. The Brookings soil is especially well suited to the species that require an abundant supply of moisture.

The Kranzburg soil is suited to building site development, but the moderate shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

The Kranzburg soil is suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Brookings soil generally is unsuitable as a site for buildings and sanitary facilities because it is subject to overland flow.

The Kranzburg soil is in capability unit IIc-2, Silty range site, and windbreak suitability group 3; the Brookings soil is in capability unit IIc-3, Overflow range site, and windbreak suitability group 1.

KrB—Kranzburg-Brookings-Buse complex, 1 to 6 percent slopes. These deep, nearly level and undulating soils are on till plains. The well drained Kranzburg soil is on back slopes, the moderately well drained Brookings soil is on foot slopes, and the well drained Buse soil is on shoulder slopes. Areas are irregular in shape and range from 10 to more than 250 acres in size. They are 40 to 50 percent Kranzburg soil, 20 to 30 percent Brookings soil, and 10 to 20 percent Buse soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Kranzburg soil is dark gray silt loam about 7 inches thick. The subsoil is about 29 inches thick. The upper part is dark grayish brown and brown, friable silt loam. The lower part is light brownish gray, firm, calcareous clay loam. The underlying material to a depth of 60 inches is pale yellow and light gray, calcareous clay loam.

Typically, the surface layer of the Brookings soil is dark gray silt loam about 8 inches thick. The subsurface layer also is dark gray silt loam. It is about 6 inches thick. The subsoil is about 24 inches thick. The upper part is dark grayish brown and light olive brown, friable silt loam. The next part is light yellowish brown, friable, calcareous silt loam. The lower part is grayish brown, mottled, firm, calcareous clay loam. The underlying material to a depth of 60 inches is light brownish gray, mottled, firm, calcareous clay loam.

Typically, the surface layer of the Buse soil is dark gray, calcareous loam about 7 inches thick. The subsoil is pale brown, friable, calcareous loam about 15 inches thick. The underlying material to a depth of 60 inches is light yellowish brown, calcareous loam.

Included with these soils in mapping are small areas

Figure 10.—Spring wheat in an area of Kranzburg-Brookings silt loams, 0 to 2 percent slopes.

of Barnes, Cresbard, Peever, and Tonka soils. These included soils make up less than 15 percent of this map unit. Barnes soils contain more sand and less silt than the Kranzburg soil. They are in landscape positions similar to those of the Kranzburg soil. Cresbard soils have a sodium-affected subsoil. They are in positions on the landscape similar to those of the Brookings soil. Peever soils contain more clay than the Kranzburg, Brookings, and Buse soils. They are in positions on the landscape similar to those of the Kranzburg soil. The poorly drained Tonka soils are in basins.

The content of organic matter is moderate in the Kranzburg soil and high in the Brookings soil. It is low to moderate in the Buse soil. Fertility is medium in the Kranzburg soil, high in the Brookings soil, and low or medium in the Buse soil. Permeability is moderate in the silty part of the Kranzburg and Brookings soils and moderately slow in the underlying glacial till. It is moderately slow in the Buse soil. Available water capacity is high in all three soils. The Brookings soil has a water table at a depth of 3 to 6 feet during wet periods. Runoff is medium on the Kranzburg and Buse soils and slow on the Brookings soil. The shrink-swell potential is moderate in all three soils.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay, but a high content of lime in the surface layer of the Buse soil limits productivity. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, barley, soybeans, and oats are the main crops. Because of runoff from the adjacent soils, planting and harvesting are delayed during some wet periods on the Brookings soil. The additional moisture is beneficial, however, in most years.

Measures that control erosion and conserve moisture are the main management needs. Improving fertility in areas of the Buse soil is an additional concern. Leaving crop residue on the surface, minimizing tillage, and including grasses and legumes in the cropping sequence help to control erosion, conserve moisture, and improve fertility. Where the slopes are suitable, terraces, contour farming, and grassed waterways help to control erosion.

No major hazards or limitations affect the use of these soils for range. Water erosion is a hazard, however, if the range is overgrazed. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity and control erosion.

These soils are suited to windbreaks and environmental plantings. Except for the species that require an abundant supply of moisture, all climatically suited trees and shrubs grow well on the Kranzburg soil. Those that require an abundant supply of moisture grow especially well on the Brookings soil. The high content of lime at or near the surface is a limitation in areas of the Buse soil. Trees and shrubs can be established, but optimum survival, growth, and vigor are unlikely.

The Kranzburg and Buse soils are suited to building site development, but the shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. The Kranzburg and Buse soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Brookings soil is generally unsuitable as a site for buildings and sanitary facilities because it is subject to overland flow.

The Kranzburg soil is in capability unit IIe-1, Silty range site, and windbreak suitability group 3; the Brookings soil is in capability unit IIc-3, Overflow range site, and windbreak suitability group 1; the Buse soil is in capability unit IIIe-12, Thin Upland range site, and windbreak suitability group 8.

Kt—Kratka loamy fine sand. This deep, poorly drained, level soil is on glacial lake plains. Areas are oval or irregularly shaped and range from 10 to 50 acres in size. Slopes are concave.

Typically, the surface layer is dark gray loamy fine sand about 10 inches thick. The subsoil is about 29 inches thick. It is mottled. The upper part is grayish brown, very friable loamy fine sand. The next part is light brownish gray, very friable, calcareous loamy fine sand. The lower part is light gray, friable, calcareous silt loam. The underlying material to a depth of 60 inches is white, calcareous silt loam. In places the depth to silt loam is more than 40 inches.

Included with this soil in mapping are small areas of Fossum, Hecla, Towner, and Ulen soils. These soils make up less than 15 percent of this map unit. Fossum soils have free lime near the surface. They are in positions on the landscape similar to those of the Kratka soil. The moderately well drained Hecla and Towner soils are on the higher parts of the landscape. Hecla soils do not have silty material within a depth of 40 inches. The somewhat poorly drained and moderately well drained Ulen soils are on toe slopes. They have accumulations of free lime within a depth of 16 inches.

The content of organic matter is moderate in the Kratka soil, and fertility is medium. Permeability is moderately rapid in the subsoil and moderate or moderately slow in the underlying material. Available water capacity is moderate or high. During wet periods the water table is at a depth of 0.5 foot to 3.0 feet. Runoff is slow. The shrink-swell potential is low in the subsoil and moderate in the underlying material.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are Garrison creeping foxtail, reed canarygrass, smooth brome, and switchgrass. Wheat, corn, oats, and barley are the main crops. The hazard of wind erosion is severe. Wetness frequently reduces crop yields and commonly delays spring planting, tillage, or harvesting. Controlling wind erosion and maintaining fertility are the main management concerns. Tillage practices that leave crop residue on the surface, field windbreaks, stripcropping, and a cropping sequence that includes grasses and legumes help to control wind erosion, conserve moisture, and maintain fertility.

If this soil is used for range, wind erosion is a hazard unless an adequate plant cover is maintained. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain productivity and an adequate plant cover. The risk of blowouts increases along overused livestock trails and around watering facilities.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on this soil, and those that require an abundant supply of moisture grow especially well. Planting after minimal site preparation helps to control wind erosion.

This soil is generally unsuited to building site development and septic tank absorption fields because of the wetness.

This soil is in capability unit IVw-2, Subirrigated range site, and windbreak suitability group 2S.

La—LaDelle silt loam. This deep, level and nearly level, moderately well drained soil is on terraces and flood plains. It is subject to rare flooding. Areas are elongated and range from 10 to 250 acres in size. Slopes are smooth or slightly concave.

Typically, the surface layer is dark gray silt loam about 7 inches thick. The subsurface layer also is dark gray silt loam. It is about 8 inches thick. The subsoil is dark gray and gray, friable, calcareous silt loam about 19 inches thick. The underlying material to a depth of 60 inches is grayish brown, calcareous silt loam. In some areas the underlying material is clayey. In other areas carbonates are below a depth of 30 inches.

Included with this soil in mapping are small areas of the poorly drained and somewhat poorly drained Lamoure and Ranslo soils on the lower parts of the landscape. These soils make up less than 10 percent of this map unit.

The content of organic matter is high in the LaDelle soil. Fertility also is high. Permeability is moderate. Available water capacity is high. The water table is at a depth of 4 to 6 feet during wet periods. Runoff is slow. The shrink-swell potential is moderate.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, soybeans, and oats are the main crops. The main management needs are measures that conserve moisture during dry periods. Leaving crop residue on the surface is an example. The flooding delays planting in some years. In most years, however, the additional moisture is beneficial and flood damage is minor.

No major hazards or limitations affect the use of this soil for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well.

This soil is generally unsuited to building site development and septic tank absorption fields because of the flooding. Sites that are better suited to building site development generally are on the adjacent uplands.

This soil is in capability unit IIc-1, Silty range site, and windbreak suitability group 1.

Lc—LaDelle silt loam, channeled. This deep, level and nearly level, moderately well drained soil is on flood plains that are dissected by stream channels. It is occasionally flooded for brief periods. Areas are elongated and range from 10 to 500 acres in size.

Typically, the surface layer is dark gray silt loam about 7 inches thick. The subsurface layer also is dark gray silt loam. It is about 8 inches thick. The subsoil is dark gray and gray, friable, calcareous silt loam about 19 inches thick. The underlying material to a depth of 60 inches is grayish brown, calcareous silt loam. In some areas the soil contains more sand and less silt. In other areas carbonates are below a depth of 30 inches.

Included with this soil in mapping are small areas of Harriet, Lamoure, and Ranslo soils on the lower parts of the landscape. These soils make up less than 10 percent of this map unit. Harriet and Ranslo soils have a sodium-affected subsoil. The somewhat poorly drained and poorly drained Lamoure soils are near the channels.

The content of organic matter is high in the LaDelle soil. Fertility also is high. Permeability is moderate. Available water capacity is high. The water table is at a depth of 4 to 6 feet during wet periods. Runoff is slow. The shrink-swell potential is moderate.

Most of the acreage is used for grazing. Many areas are covered by trees and shrubs. No major hazards or limitations affect the use of this soil for grazing. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

Because of the meandering stream channels and the flooding, this soil is generally unsuited to cultivated crops. In areas that are accessible to farm machinery, however, it is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. The flooding delays farming in most years.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, and those that require an abundant supply of moisture grow especially well. Because of the meandering stream channels, the trees and shrubs generally must be planted by hand rather than by machine.

This soil is generally unsuitable as a site for buildings and septic tank absorption fields because of the flooding.

This soil is in capability unit VIw-1, Overflow range site, and windbreak suitability group 1.

Le—Lamoure silty clay loam. This deep, somewhat poorly drained, level and nearly level soil is on flood plains. It is occasionally flooded for brief periods. Areas are long and narrow and range from 10 to 200 acres in size.

Typically, the surface layer is dark gray, calcareous silty clay loam about 7 inches thick. The subsurface layer also is dark gray, calcareous silty clay loam. It is

about 9 inches thick. The next 20 inches is gray, calcareous silty clay loam. The underlying material is gray, calcareous silty clay loam about 4 inches thick. The next 5 inches is dark gray, calcareous silty clay loam. Below this to a depth of 60 inches is white, calcareous loamy very fine sand. In places the soil is dark to a depth of less than 24 inches.

Included with this soil in mapping are small areas of LaDelle, Ludden, and Playmoor soils. These soils make up less than 15 percent of this map unit. The moderately well drained LaDelle soils are on terraces. Ludden soils contain more clay than the Lamoure soil. They are on the lower flood plains. Playmoor soils have visible salts throughout. They are in positions on the landscape similar to those of the Lamoure soil.

The content of organic matter is high in the Lamoure soil, and fertility is medium or high. Permeability is moderate or moderately slow. Available water capacity is high. The water table is at a depth of 0.5 foot to 2.0 feet early in the growing season. Runoff is slow. The shrink-swell potential is moderate.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, Garrison creeping foxtail, and reed canarygrass. Wheat, corn, and barley are the main crops. The main management needs are measures that reduce the seasonal wetness and maintain fertility. Leaving crop residue on the surface, minimizing tillage, and including grasses and legumes in the cropping sequence help to maintain fertility. The wetness and the flooding delay fieldwork in some years. Surface drains and underground drains can lower the water table in areas where outlets are available. In some areas dikes can be constructed to reduce the severity of the flooding.

No major hazards or limitations affect the use of this soil for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, and those that require an abundant supply of moisture grow especially well.

This soil is unsuited to building site development and septic tank absorption fields because of the flooding and the wetness. Sites that are better suited to building site development generally are available on the adjacent uplands.

This soil is in capability unit IIw-2, Subirrigated range site, and windbreak suitability group 2W.

Lg—La Prairie loam. This deep, moderately well drained, level and nearly level soil is on terraces and flood plains. It is occasionally flooded for brief periods in the spring. Areas are long and narrow or irregularly shaped. They are 25 to more than 400 acres in size. Slopes are smooth or slightly concave.

Typically, the surface layer is dark gray loam about 10 inches thick. The subsurface layer also is dark gray loam. It is about 6 inches thick. The subsoil is grayish brown, very friable loam about 9 inches thick. The underlying material to a depth of 60 inches is light brownish gray loam, sandy clay loam, and clay loam. It is calcareous in the lower part.

Included with this soil in mapping are small areas of Brantford Variant, Harriet, and Ranslo soils. These soils make up less than 15 percent of this map unit. The well drained Brantford Variant soils are in the slightly higher positions on the landscape. The poorly drained Harriet soils are on flood plains. Ranslo soils are intermingled with areas of the La Prairie soil. They have a sodium-affected subsoil and contain more clay than the La Prairie soil.

The content of organic matter is high in the La Prairie soil. Fertility also is high. Permeability is moderate. Available water capacity is high. The water table is at a depth of 3.5 to 6.0 feet during wet periods. Runoff is slow. The shrink-swell potential is moderate.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Alfalfa, intermediate wheatgrass, and smooth brome are examples of suitable pasture plants. Wheat, barley, corn, and oats are the main crops. Planting and harvesting are delayed during some wet periods. Measures that control erosion and conserve moisture are the main management needs. Examples are tillage practices that leave crop residue on the surface.

No major hazards or limitations affect the use of this soil for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, especially those that require an abundant supply of moisture.

This soil is generally unsuited to building site development and septic tank absorption fields because of the flooding.

This soil is in capability unit IIc-1, Overflow range site, and windbreak suitability group 1.

Lh—La Prairie-Harriet loams. These deep, level and nearly level soils are on flood plains that are occasionally flooded for very brief to long periods. Meandering stream channels dissect many areas. The moderately well drained La Prairie soil is on terraces, and the poorly drained Harriet soil is on flood plains near the stream channels. Areas are long and narrow

and range from 10 to more than 200 acres in size. They are about 40 to 60 percent La Prairie soil and 20 to 40 percent Harriet soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the La Prairie soil is dark gray loam about 10 inches thick. The subsurface layer also is dark gray loam. It is about 6 inches thick. The subsoil is grayish brown, very friable loam about 9 inches thick. The underlying material to a depth of 60 inches is light brownish gray. It is loam and sandy clay loam in the upper part and calcareous clay loam in the lower part. In places the soil has less sand and more silt.

Typically, the surface layer of the Harriet soil is gray loam about 2 inches thick. The subsoil is calcareous clay loam about 24 inches thick. It is dark gray and very firm and firm in the upper part and gray and firm in the lower part. It has nests of salt throughout. The underlying material to a depth of 60 inches is gray, calcareous clay loam.

Included with these soils in mapping are small areas of Edgeley, Lamoure, and Ranslo soils. These included soils make up less than 20 percent of this map unit. Edgeley soils have shale at a depth of 20 to 40 inches. They are on back slopes. The somewhat poorly drained and poorly drained Lamoure soils have more silt and less sand than the major soils. They are in positions on the landscape similar to those of the Harriet soil. The somewhat poorly drained Ranslo soils are in slightly higher positions on the landscape than the Harriet soil.

The content of organic matter is high in the La Prairie soil and moderate in the Harriet soil. Fertility is high in the La Prairie soil and low or medium in the Harriet soil. The Harriet soil has a sodium-affected subsoil. Available water capacity is high in the La Prairie soil and moderate in the Harriet soil. Permeability is moderate in the La Prairie soil and very slow in the Harriet soil. Runoff is slow on both soils. During wet periods the water table is at a depth of 3.5 to 6.0 feet in the La Prairie soil and within a depth of 1.0 foot in the Harriet soil. The shrink-swell potential is moderate in the La Prairie soil and high in the Harriet soil.

Most of the acreage supports native grasses and is used for grazing. No major hazards or limitations affect the use of the La Prairie soil for range, but the dense, compact, salt-affected subsoil is a limitation in the Harriet soil. Grazing when the Harriet soil is wet causes surface compaction and puddling, both of which result in an increase in the extent of the less desirable grasses and of weeds. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are generally unsuited to cultivated crops because they are dissected into small tracts by the meandering stream channels and are subject to flooding. In areas that are accessible to farm machinery, however, the La Prairie soil is suited to cultivated crops. No crops grow well on the Harriet soil because the sodium-affected subsoil restricts root penetration. Wheat, barley, and oats are the main crops. The main management needs on the La Prairie soil are measures that conserve moisture during dry periods. Leaving crop residue on the surface is an example.

These soils are suited to tame pasture and hay, but the choice of pasture plants is limited because of the high salinity in the Harriet soil. Alfalfa, intermediate wheatgrass, and smooth brome are suitable species on the La Prairie soil. Tall wheatgrass and western wheatgrass are the best suited species on the Harriet soil.

The La Prairie soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, especially those that require an abundant supply of moisture. Because of the meandering channels, however, they generally cannot be planted by machine. The Harriet soil is generally unsuited to windbreaks and environmental plantings because of the wetness and the high content of salts in the subsoil.

These soils are generally unsuited to building site development and septic tank absorption fields because of the wetness and the flooding.

The La Prairie soil is in capability unit IIc-1, Overflow range site, and windbreak suitability group 1; the Harriet soil is in capability unit VIs-6, Saline Lowland range site, and windbreak suitability group 10.

Lm—Letcher-Embden-Miranda complex. These deep, level and nearly level soils are on till plains. The moderately well drained and somewhat poorly drained Letcher soil is on the upper foot slopes. The well drained and moderately well drained Embden soil is on the lower back slopes. The moderately well drained and somewhat poorly drained Miranda soil is on foot slopes. Areas are irregular in shape and range from 15 to 100 acres in size. They are 30 to 40 percent Letcher soil, 25 to 35 percent Embden soil, and 15 to 25 percent Miranda soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Letcher soil is dark gray fine sandy loam about 8 inches thick. The subsurface layer is light brownish gray loamy fine sand about 5 inches thick. The subsoil is grayish brown, friable and very friable, calcareous sandy loam about 14 inches thick. The next layer to a depth of 34 inches is

grayish brown, calcareous loam. Below this to a depth of 45 inches is brown and light gray, calcareous loam that has nests of salt. The underlying material to a depth of 60 inches is light brownish gray, calcareous sandy loam. In some areas clay loam glacial till is below a depth of 40 inches. In other areas the subsoil contains more clay.

Typically, the surface layer of the Embden soil is dark gray fine sandy loam about 7 inches thick. The subsurface layer also is dark gray fine sandy loam. It is about 9 inches thick. The subsoil is very friable fine sandy loam about 27 inches thick. The upper part is grayish brown, and the lower part is calcareous and light gray. The underlying material to a depth of 60 inches is light gray, calcareous very fine sandy loam.

Typically, the surface layer of the Miranda soil is gray loam about 4 inches thick. The subsoil is firm clay loam about 25 inches thick. The upper part is grayish brown and dark grayish brown. The next part is light olive brown and has nests of gypsum and other salts. The lower part is light yellowish brown, is calcareous, and has nests of salt and gypsum. The underlying material to a depth of 60 inches is light brownish gray and light yellowish brown, calcareous clay loam that has nests of salt and gypsum.

Included with these soils in mapping are small areas of Koto, Niobell, Tally, and Williams soils. These included soils make up less than 15 percent of this map unit. The poorly drained Koto soils are in basins. Niobell soils have more clay in the subsoil than the Letcher and Embden soils and have salts at a greater depth than the Miranda soil. They are in positions on the landscape similar to those of the Letcher soil. Tally and Williams soils do not have a sodium-affected subsoil. They are on the upper back slopes. Tally soils are dark to a depth of less than 16 inches. Williams soils contain more clay in the subsoil than the Letcher and Embden soils.

The content of organic matter is moderate in the Letcher, Embden, and Miranda soils. Fertility is medium in the Letcher and Embden soils and low or medium in the Miranda soil. Permeability is slow in the subsoil of the Letcher soil and moderate or moderately rapid in the underlying material. It is moderately rapid in the Embden soil and very slow in the Miranda soil. During wet periods, the Letcher soil has a water table at a depth of 3.5 to 6.0 feet and the Embden soil has one at a depth of 4.0 to 6.0 feet. Available water capacity is low or moderate in the Letcher soil and moderate in the Embden and Miranda soils. Runoff is slow on all three soils. The shrink-swell potential is low in the Letcher and Embden soils and moderate in the Miranda soil.

Most of the acreage supports native grasses and is used for grazing or hay. If these soils are used for range, the dense, sodium-affected subsoil in the Letcher and Miranda soils limits productivity and the variety of suitable grasses. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils generally are poorly suited to cultivated crops and to tame pasture and hay. Crop growth is severely restricted on the Letcher soil because of the dense, sodium-affected subsoil. The Embden soil is suited to cultivated crops, but no crops grow well on the Miranda soil. Alfalfa, intermediate wheatgrass, crested wheatgrass, and smooth brome are examples of suitable pasture plants. Wheat, barley, and oats are the main cultivated crops. The subsoil of the Letcher and Miranda soils takes in water slowly and releases it slowly to plants. Measures that conserve moisture, improve tilth, and control erosion are the main management needs. Examples are leaving crop residue on the surface, minimizing tillage, and including grasses and legumes in the cropping sequence. Chiseling or subsoiling improves tilth and increases the rate of water intake.

The Letcher and Embden soils are suited to windbreaks and environmental plantings. Trees and shrubs can be established on the Letcher soil, but the dense, sodium-affected subsoil severely limits root penetration. Optimum growth, survival, and vigor are unlikely. All climatically suited trees and shrubs grow well on the Embden soil, and those that require an abundant supply of moisture grow especially well. No trees or shrubs grow well on the Miranda soil.

These soils are suited to most kinds of building site development, but the wetness in areas of the Letcher and Embden soils and the moderate shrink-swell potential in areas of the Miranda soil are limitations. The sides of shallow excavations in areas of the Embden soil tend to cave in unless they are shored. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by wetness and by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are generally unsuited to septic tank absorption fields because of the wetness in the Letcher and Embden soils and the restricted permeability in the Miranda soil.

The Letcher soil is in capability unit IVe-13, Sandy range site, and windbreak suitability group 9; the Embden soil is in capability unit IIIe-7, Sandy range

site, and windbreak suitability group 1; the Miranda soil is in capability unit VIs-1, Thin Claypan range site, and windbreak suitability group 10.

Lu—Ludden silty clay. This deep, poorly drained, level soil is on flood plains. It is frequently flooded for brief to long periods. Some areas are dissected by shallow drainageways. Areas are irregular in shape and range from 10 to 200 acres in size. Slopes are smooth or slightly concave.

Typically, the surface layer is dark gray, calcareous silty clay about 8 inches thick. The subsoil is dark gray, firm, calcareous silty clay about 29 inches thick. The underlying material to a depth of 60 inches is gray, calcareous silty clay and clay loam. In places carbonates are farther from the surface.

Included with this soil in mapping are small areas of Lamoure and Playmoor soils. These soils make up less than 15 percent of this map unit. Lamoure and Playmoor soils contain more silt and less clay than the Ludden soil. Playmoor soils have visible salts throughout. Lamoure soils are in the slightly higher positions on the landscape. Playmoor soils are in positions on the landscape similar to those of the Ludden soil.

The content of organic matter is high in the Ludden soil, and fertility is medium. Tilth is poor. Permeability is slow. Available water capacity is moderate or high. The water table is within a depth of 2 feet early in the growing season. Runoff is slow or very slow. The shrink-swell potential is high.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. The choice of suitable tame pasture plants is limited to water-tolerant species, such as Garrison creeping foxtail and reed canarygrass. Corn, barley, wheat, soybeans, and sunflowers are the main crops. Lime in the surface layer restricts the availability of plant nutrients. The main management concerns are reducing wetness, improving tilth, and maintaining fertility. Minimizing tillage, leaving crop residue on the surface, delaying tillage when the soil is wet, and including grasses and legumes in the cropping sequence improve tilth and fertility. Diverting runoff from the adjacent soils and installing a drainage system where one is feasible reduce the wetness.

If this soil is used for range, compaction can be a problem. Grazing during wet periods causes compaction of the surface layer, which results in an increase in the extent of the less desirable grasses and of weeds. Proper stocking rates and timely deferment of grazing help to maintain maximum productivity.

This soil is generally suited to windbreaks and environmental plantings.

This soil is generally unsuited to building site development and septic tank absorption fields because of the flooding and the wetness.

This soil is in capability unit IVw-1, Wetland range site, and windbreak suitability group 10.

Lw—Ludden silty clay, ponded. This deep, very poorly drained, level soil is on flood plains and in basins in the uplands. It is frequently flooded and is ponded during most of the year. Areas are circular or are long and narrow and range from 5 to 150 acres in size.

Typically, the surface layer is dark gray, calcareous silty clay about 8 inches thick. The subsoil is dark gray, firm, calcareous silty clay about 29 inches thick. The underlying material to a depth of 60 inches is gray, calcareous silty clay and clay loam. In some places carbonates are farther from the surface. In other places the soil contains less clay.

Included with this soil in mapping are small areas of the poorly drained Borup and Colvin soils. These soils make up less than 10 percent of this map unit. They have accumulations of lime within a depth of 16 inches. They are on toe slopes.

The content of organic matter is high in the Ludden soil. Fertility also is high. Permeability is slow. Available water capacity is moderate or high. The water table is within a depth of 1 foot. As much as 2 feet of water ponds on the surface during some wet periods. Runoff is ponded. The shrink-swell potential is high.

Most areas support native vegetation and are used as wetland wildlife habitat. Deer, pheasants, and other wildlife frequent the margins of these areas. The native vegetation, which includes cattails, rushes, and sedges, provides food and cover for a variety of waterfowl and wetland birds. Ducks nest on the drier adjacent sites and raise their young in the ponded areas. Geese and other waterfowl use these areas as periodic resting and feeding sites during migration. The vegetated areas commonly are interspersed with small bodies of open water.

Because of the ponding, this soil is generally unsuited to cultivated crops, tame pasture and hay, windbreaks and environmental plantings, building site development, and septic tank absorption fields.

This soil is in capability unit VIIIw-1 and windbreak suitability group 10. No range site is assigned.

Lx—Ludden-Ludden, saline, silty clays. These deep, poorly drained, level and nearly level soils are on flood plains. They are frequently flooded for brief to long periods. Areas are irregular in shape and range from 10 to 200 acres in size. They are 40 to 50 percent Ludden soil and 35 to 45 percent saline Ludden soil. The two soils occur as areas so closely intermingled or so small

that mapping them separately is not practical.

Typically, the surface layer of the Ludden soil is dark gray, calcareous silty clay about 8 inches thick. The subsoil is dark gray, firm, calcareous silty clay about 29 inches thick. The underlying material to a depth of 60 inches is gray, calcareous silty clay and clay loam. In places carbonates are farther from the surface.

Typically, the surface layer of the saline Ludden soil is dark gray, calcareous silty clay about 8 inches thick. It has nests of salt. The subsoil is dark gray, firm, calcareous silty clay about 29 inches thick. It has nests of salt. The underlying material to a depth of 60 inches is gray, calcareous silty clay and clay loam.

Included with these soils in mapping are small areas of Lamoure and Playmoor soils. These included soils make up less than 15 percent of this map unit. Lamoure and Playmoor soils contain more silt and less clay than the major soils. Lamoure soils are in the slightly higher positions on the landscape. Playmoor soils are in positions on the landscape similar to those of the saline Ludden soil.

The content of organic matter is high in both of the Ludden soils. Fertility is low in the saline Ludden soil and medium in the other Ludden soil. Tilth is poor in both soils. Permeability is slow. Available water capacity is low or moderate in the saline Ludden soil and moderate or high in the other Ludden soil. The water table is within a depth of 2 feet early in the growing season in both soils. Runoff is slow or very slow. The shrink-swell potential is high.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are Garrison creeping foxtail, reed canarygrass, and tall wheatgrass. The excess salts in the root zone of the saline Ludden soil and excess lime in the surface layer of both soils restrict the availability of plant nutrients. The main management concerns are reducing wetness, maintaining fertility, and improving tilth. Minimizing tillage, leaving crop residue on the surface, delaying tillage when the soil is wet, and including grasses and legumes in the cropping sequence improve tilth and fertility. Diverting runoff from the adjacent soils and installing a drainage system reduce the wetness.

If these soils are used for range, compaction can be a problem. Grazing during wet periods causes compaction of the surface layer, which results in an increase in the extent of the less desirable grasses and of weeds. Proper stocking rates and timely deferment of grazing help to maintain productivity.

These soils are generally unsuited to windbreaks and environmental plantings. Optimum growth, survival, and vigor are unlikely.

These soils are generally unsuited to building site development and septic tank absorption fields because of the wetness and the flooding.

The Ludden soil is in capability unit IVw-1, Wetland range site, and windbreak suitability group 10; the saline Ludden soil is in capability unit IVw-5, Saline Lowland range site, and windbreak suitability group 10.

Lz—Ludden silty clay, ponded-Water complex. This map unit consists of a deep, very poorly drained, level soil and areas of water. It is on flood plains. Most areas of this map unit are in Sand Lake National Wildlife Refuge. They are frequently flooded for brief to long periods. In most years the Ludden soil is ponded by as much as 2 feet of water during the growing season. It is interspersed with open water areas that range from less than 1 acre to sizes as large as the Columbia Road Reservoir. Areas of this unit are 45 to 55 percent Ludden soil and 35 to 45 percent open water.

Typically, the surface layer of the Ludden soil is dark gray, calcareous silty clay about 8 inches thick. The subsoil is dark gray, calcareous, firm silty clay about 29 inches thick. The underlying material to a depth of 60 inches is gray, calcareous silty clay and clay loam. In places carbonates are farther from the surface.

Included in mapping are small areas of Arveson, Fossum, Hecla, Lamoure, and Playmoor soils. These soils make up less than 10 percent of this map unit. The poorly drained and very poorly drained Arveson and Fossum soils and the moderately well drained Hecla soils are in the slightly higher positions on the landscape. They contain more sand than the Ludden soil. Lamoure and Playmoor soils contain less clay and more silt than the Ludden soil. Lamoure soils are in the slightly higher positions on the landscape. Playmoor soils are in positions on the landscape similar to those of the Ludden soil.

The content of organic matter is high in the Ludden soil. Fertility also is high. Permeability is slow. Available water capacity is moderate or high. The seasonal high water table is within a depth of 1 foot. As much as 2 feet of water ponds on the surface during some wet periods. Runoff is ponded. The shrink-swell potential is high.

Most areas support native vegetation and are used as wetland wildlife habitat. Deer, geese, ducks, pheasant, and other wildlife frequent the margins of these areas. Ducks, geese, and other waterfowl use these areas as periodic resting and feeding sites during migration in spring and fall. The native vegetation, which includes cattails, rushes, and sedges, provides food and cover for a variety of waterfowl and wetland birds. The many interspersed small bodies of open water also provide protection for waterfowl.

Because of the ponding, the Ludden soil is generally

unsuited to cultivated crops, tame pasture and hay, windbreaks and environmental plantings, building site development, and septic tank absorption fields.

The Ludden soil is in capability unit VIIIw-1 and windbreak suitability group 10. No range site is assigned.

MaB—Maddock-Hecla-Hamar loamy fine sands, 2 to 8 percent slopes. These deep, gently undulating to gently rolling soils are on sandy glacial lake plains. Most areas have been reworked by wind and have many small blowouts, low hummocks, and intervening shallow basins. The well drained Maddock soil is on shoulder slopes, the moderately well drained Hecla soil is on the lower back slopes, and the somewhat poorly drained Hamar soil is in basins. Areas are irregular in shape and range from 20 to 400 acres in size. They are 30 to 40 percent Maddock soil, 25 to 35 percent Hecla soil, and 15 to 25 percent Hamar soil. The three soils occur as areas so closely intermingled that mapping them separately is not practical.

Typically, the surface soil of the Maddock soil is dark gray loamy fine sand about 13 inches thick. The underlying material is grayish brown loamy fine sand about 29 inches thick. The next layer is grayish brown, calcareous fine sandy loam about 6 inches thick. Below this to a depth of 60 inches is light brownish gray, calcareous fine sandy loam.

Typically, the surface layer of the Hecla soil is dark gray loamy fine sand about 6 inches thick. The subsurface layer is dark gray fine sand about 14 inches thick. The next layer also is dark gray fine sand. It is about 10 inches thick. The underlying material to a depth of 54 inches is grayish brown fine sand. The next layer to a depth of 60 inches is very dark gray fine sandy loam. In places silty sediments are within a depth of 40 inches.

Typically, the surface layer of the Hamar soil is dark gray loamy fine sand about 7 inches thick. The subsurface layer is dark gray, mottled loamy fine sand about 10 inches thick. The underlying material to a depth of 60 inches is grayish brown, mottled fine sand. It is calcareous in the lower part. In places silty sediments are within a depth of 40 inches.

Included with these soils in mapping are small areas of Fossum, Ulen, and Venlo soils. These included soils make up less than 15 percent of this map unit. Fossum and Ulen soils have free lime at the surface. They are in positions on the landscape similar to those of the Hamar soil. The very poorly drained Venlo soils are slightly lower on the landscape than the Hamar soil.

The content of organic matter is low in the Maddock soil and moderate in the Hecla and Hamar soils. Fertility is low in the Maddock soil and medium in the Hecla and Hamar soils. Permeability is rapid in the subsoil of the Maddock soil and moderate in the underlying material. It is rapid or moderately rapid in the Hecla and Hamar soils. Available water capacity is low in the Maddock soil and low or moderate in the Hecla and Hamar soils. During wet periods, the Hecla soil has a seasonal high water table at a depth of 3 to 6 feet and the Hamar soil has one within a depth of 2 feet. Runoff is very slow on the Maddock soil and slow on the Hecla and Hamar soils.

Most of the acreage supports native grasses and is used for grazing. Wind erosion is a major hazard unless adequate plant cover is maintained. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain productivity and an adequate plant cover. The risk of blowouts increases along livestock trails and around watering facilities.

The Maddock and Hecla soils are generally unsuited to cultivated crops and to tame pasture and hay because of a severe hazard of wind erosion. Past wind erosion has created a hummocky landscape that has many blowouts in some areas. Cultivation is generally not practical without some land shaping. The Hamar soil is suited to cultivated crops and to tame pasture and hay, but it is so closely intermingled with areas of the Maddock and Hecla soils that cultivation is not practical.

These soils are suited to windbreaks and environmental plantings, but site preparation is difficult because of the eroded landscape. All climatically suited trees and shrubs grow well. Windbreaks are very effective in reducing the hazard of wind erosion.

Because of the high water table, the Hecla and Hamar soils are less well suited to building site development than the Maddock soil. Installing foundation drains in areas of the Hecla and Hamar soils helps to prevent seepage into basements. Cutbanks in shallow excavations tend to cave in unless they are shored.

Because of the wetness in the Hecla and Hamar soils and a poor filtering capacity in all three soils, this map unit is generally unsuited to septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water.

The Maddock soil is in capability unit VIe-7, Sands range site, and windbreak suitability group 5; the Hecla soil is in capability unit IVe-10, Sandy range site, and windbreak suitability group 1; the Hamar soil is in capability unit IVw-2, Subirrigated range site, and windbreak suitability group 2S.

Na—Nahon-Aberdeen-Exline silt loams. These deep, level and nearly level soils are on glacial lake plains. The moderately well drained and somewhat poorly drained Nahon soil is on the lower foot slopes,

the moderately well drained Aberdeen soil is on the upper foot slopes, and the somewhat poorly drained Exline soil is on toe slopes. Areas are irregular in shape and range from 20 to more than 200 acres in size. They are 45 to 55 percent Nahon soil, 15 to 25 percent Aberdeen soil, and 10 to 20 percent Exline soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Nahon soil is dark gray silt loam about 6 inches thick. The subsurface layer is gray silt loam about 3 inches thick. The subsoil is about 28 inches thick. The upper part is gray, firm silty clay and grayish brown, firm silty clay loam. The lower part is light brownish gray and pale yellow, firm and friable, calcareous silty clay loam. It has nests of gypsum and other salts. The underlying material to a depth of 60 inches is white and grayish brown, calcareous silty clay loam and clay varved with very fine sandy loam and silty clay.

Typically, the surface layer of the Aberdeen soil is dark gray silt loam about 8 inches thick. Below this is a mixed layer about 3 inches thick. This layer is gray silty clay loam that has gray silt coatings on faces of peds. The subsoil is about 27 inches thick. The upper part is dark gray, firm silty clay. The lower part is light gray and light brownish gray, firm, calcareous silty clay loam that has nests of gypsum and other salts. The upper part of the underlying material is light gray, calcareous silt loam. The lower part to a depth of 60 inches is pale yellow, calcareous silt loam varved with silty clay and very fine sandy loam.

Typically, the surface layer of the Exline soil is dark gray silt loam about 2 inches thick. The subsurface layer is gray silt loam about 1 inch thick. The subsoil is about 31 inches thick. It is calcareous in the lower 23 inches. The upper part is dark gray, very firm clay. The next part is dark gray, gray, and light brownish gray, very firm clay that has nests of salt. The lower part is light brownish gray, firm silty clay loam. The underlying material to a depth of 60 inches is light gray, calcareous silty clay loam that is varved.

Included with these soils in mapping are small areas of Bearden, Beotia, and Harmony soils. These included soils make up less than 15 percent of this map unit. They do not have a sodium-affected subsoil. Bearden and Beotia soils contain less clay than the major soils. Bearden soils are on toe slopes between and around basins. Beotia soils are slightly higher on the landscape than the major soils. Harmony soils are slightly higher on the landscape than the Nahon and Exline soils and occur as areas intermingled with areas of the Aberdeen soil.

The content of organic matter is moderate in the Nahon, Aberdeen, and Exline soils. Fertility is medium in the Nahon and Aberdeen soils and low in the Exline soil. All three soils have a sodium-affected subsoil that restricts the penetration of roots. Tilth is poor in the Nahon and Exline soil and fair in the Aberdeen soil. Permeability is very slow in the subsoil of the Nahon soil and moderately slow to very slow in the underlying material. It is slow in the subsoil of the Aberdeen soil and moderate to slow in the underlying material. It is very slow in the Exline soil. Available water capacity is moderate in the Nahon and Exline soils and moderate or high in the Aberdeen soil. During wet periods, the Nahon and Aberdeen soils have a water table at a depth of 4.0 to 6.0 feet and the Exline soil has one at a depth of 2.5 to 4.0 feet. Runoff is slow on all three soils. The shrink-swell potential is high in the subsoil. It is moderate in the underlying material of the Nahon and Exline soils and low in the underlying material of the Aberdeen soil.

Most of the acreage is cropland. No crops grow well on the Exline soil, but the Nahon and Aberdeen soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, pubescent wheatgrass, and crested wheatgrass. Barley, wheat, and alfalfa are the main crops. The dense claypan subsoil in the Nahon and Exline soils and the sodium in all three soils restrict crop growth by limiting root penetration and the rate of water intake. Measures that improve tilth and increase the rate of water intake are the main management needs. Tillage practices that leave crop residue on the surface, chiseling or subsoiling, timely tillage, and a cropping sequence that includes grasses and legumes are examples.

If these soils are used for range, the dense claypan subsoil in the Nahon and Exline soils limits productivity and the variety of suitable grasses. Surface compaction is a major problem. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain productivity.

The Nahon and Aberdeen soils are suited to windbreaks and environmental plantings, but the Exline soil is generally unsuited. The sodium-affected subsoil in all three soils and the high content of salts in the Exline soil are limitations. Trees and shrubs can be established on the Nahon and Aberdeen soils, but optimum growth, survival, and vigor are unlikely. No trees or shrubs grow well on the Exline soil.

These soils are suited to building site development, but the high shrink-swell potential is a limitation. The wetness in areas of the Exline soil is an additional limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the

buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

The Nahon and Aberdeen soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. The varves in the underlying material result in the slow absorption of liquid waste. Enlarging the absorption area helps to overcome the slow absorption rate. The Exline soil is generally unsuited to septic tank absorption fields because of the wetness and the restricted permeability.

The Nahon soil is in capability unit IVs-2, Claypan range site, and windbreak suitability group 9; the Aberdeen soil is in capability unit IIIs-1, Clayey range site, and windbreak suitability group 4L; the Exline soil is in capability unit VIs-1, Thin Claypan range site, and windbreak suitability group 10.

Nc—Nahon-Aberdeen-Exline silty clay loams, sandy substratum. These deep, level and nearly level soils are on outwash plains. The moderately well drained and somewhat poorly drained Nahon soil is on the lower foot slopes, the moderately well drained Aberdeen soil is on the upper foot slopes, and the somewhat poorly drained Exline soil is on toe slopes. Areas are irregular in shape and range from 10 to more than 100 acres in size. They are 45 to 55 percent Nahon soil, 15 to 25 percent Aberdeen soil, and 10 to 20 percent Exline soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Nahon soil is dark gray silty clay loam about 6 inches thick. The subsurface layer is gray silt loam about 3 inches thick. The subsoil is about 28 inches thick. The upper part is gray, firm silty clay and grayish brown, firm silty clay loam. The lower part is light brownish gray and pale yellow, firm and friable silty clay loam. It is calcareous and has nests of gypsum and other salts. The upper part of the underlying material is white and grayish brown, calcareous silty clay loam. The lower part to a depth of 60 inches is light brownish gray fine sand.

Typically, the surface layer of the Aberdeen soil is dark gray silty clay loam about 8 inches thick. Below this is a mixed layer about 3 inches thick. This layer is gray silty clay loam that has gray silt coatings on faces of peds. The subsoil is about 27 inches thick. It is firm. The upper part is dark gray silty clay. The lower part is light gray and light brownish gray, calcareous silty clay loam that has nests of gypsum and other salts. The upper part of the underlying material is light gray, calcareous silt loam. The lower part to a depth of 60 inches is light brownish gray fine sand.

Typically, the surface layer of the Exline soil is dark gray silty clay loam about 2 inches thick. The subsurface layer is gray silt loam about 1 inch thick. The subsoil is about 31 inches thick. It is calcareous in the lower 23 inches. The upper part is dark gray, very firm clay. The next part is dark gray, gray, and light brownish gray, very firm clay that has nests of salt. The lower part is light brownish gray, firm silty clay loam. The upper part of the underlying material is light gray, calcareous silty clay loam. The lower part to a depth of 60 inches is light brownish gray fine sand.

Included with these soils in mapping are small areas of Harmony Variant and Tiffany Variant soils. These included soils make up less than 15 percent of this map unit. They do not have a sodium-affected subsoil. They are slightly higher on the landscape than the Nahon, Aberdeen, and Exline soils.

The content of organic matter is moderate in the Nahon, Aberdeen, and Exline soils. Fertility is medium in the Nahon and Aberdeen soils and low in the Exline soil. All three soils have a sodium-affected subsoil that restricts the penetration of roots. Tilth is poor in the Nahon and Exline soils and fair in the Aberdeen soil. Permeability is very slow in the subsoil of the Nahon and Exline soils and rapid in the sandy underlying material. It is slow in the subsoil of the Aberdeen soil and rapid in the sandy underlying material. Available water capacity is moderate in the Nahon soil, moderate or high in the Aberdeen soil, and moderate or low in the Exline soil. During wet periods the water table is at a depth of 3.5 to 6.0 feet in the Nahon and Aberdeen soils and 2.5 to 4.0 feet in the Exline soil. Runoff is slow on all three soils. The shrink-swell potential is high in the subsoil and low in the underlying material.

Most of the acreage is cropland. The Nahon and Aberdeen soils are suited to cultivated crops and to tame pasture and hay. The dense claypan subsoil in the Nahon soil and the sodium in both soils restrict crop growth by limiting root penetration and the rate of water intake. The Exline soil is generally unsuited to cultivated crops because the dense claypan subsoil and the high content of salts restrict root penetration and the availability of plant nutrients. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, pubescent wheatgrass, and crested wheatgrass. Barley, wheat, and alfalfa are the main crops. Measures that improve tilth and increase the rate of water intake are the main management needs. Tillage practices that leave crop residue on the surface, chiseling or subsoiling, timely tillage, and a cropping sequence that includes grasses and legumes are examples.

If these soils are used for range, the dense claypan subsoil in the Nahon and Exline soils limits productivity. Surface compaction is a major problem on all three soils. Restricted grazing during wet periods helps to

prevent compaction and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum production.

The Nahon and Aberdeen soils are suited to windbreaks and environmental plantings, but the Exline soil is generally unsuited. The sodium-affected subsoil in all three soils and the high content of salts in the Exline soil are limitations. Trees and shrubs can be established on the Nahon and Aberdeen soils, but optimum growth, survival, and vigor are unlikely. No trees or shrubs grow well on the Exline soil.

These soils are suited to building site development, but the high shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. The soils are generally unsuited to septic tank absorption fields because of the wetness and the restricted permeability.

The Nahon soil is in capability unit IVs-2, Claypan range site, and windbreak suitability group 9; the Aberdeen soil is in capability unit IIIs-1, Clayey range site, and windbreak suitability group 4L; the Exline soil is in capability unit VIs-1, Thin Claypan range site, and windbreak suitability group 10.

NeA—Niobell-Noonan-Williams loams, 1 to 4 percent slopes. These deep, nearly level to undulating soils are on till plains. The moderately well drained Niobell soil is on the upper foot slopes, the moderately well drained Noonan soil is on the lower foot slopes, and the well drained Williams soil is on back slopes. Areas are irregular in shape and range from 15 to more than 1,000 acres in size. They are 35 to 45 percent Niobell soil, 25 to 35 percent Noonan soil, and 15 to 25 percent Williams soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Niobell soil is dark grayish brown loam about 8 inches thick. The subsurface layer is grayish brown loam about 2 inches thick. Below this is a transitional layer of dark grayish brown and light brownish gray clay loam about 6 inches thick. The subsoil is grayish brown, yellowish brown, and light yellowish brown, friable clay loam about 30 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is pale yellow, calcareous clay loam. In places the subsoil contains more clay.

Typically, the surface layer of the Noonan soil is dark grayish brown loam about 7 inches thick. The subsurface layer is grayish brown loam about 2 inches thick. The subsoil is clay loam about 45 inches thick. The upper part is dark grayish brown and firm. The next part is light olive brown and friable. It has nests of gypsum and other salts. The lower part is light brownish gray, friable, and calcareous. The underlying material to a depth of 60 inches is light brownish gray, calcareous clay loam. In places the subsoil contains more clay.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is brown, grayish brown, light brownish gray, and light gray, friable clay loam about 33 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light brownish gray, calcareous clay loam. In some areas the subsoil contains less clay. In other areas carbonates are within a depth of 10 inches.

Included with these soils in mapping are small areas of Heil, Miranda, and Tally soils. These included soils make up less than 10 percent of this map unit. The poorly drained Heil soils are in basins. Miranda soils have visible salts within a depth of 16 inches. They are in the slightly lower positions on the landscape. Tally soils contain more sand throughout than the major soils. Also, they contain less clay in the subsoil. They are on summits.

The content of organic matter is moderate in the Niobell, Noonan, and Williams soils, and fertility is medium. The Niobell and Noonan soils have a sodium-affected subsoil. Tilth is good in the Niobell and Williams soils and poor in the Noonan soil. Permeability is slow in the Niobell and Noonan soils. It is moderate in the subsoil of the Williams soil and moderately slow in the underlying material. Available water capacity is moderate or high in the Niobell soil, moderate in the Noonan soil, and high in the Williams soil. Runoff is medium on all three soils. The shrink-swell potential is high in the subsoil of the Niobell and Noonan soils and moderate in the underlying material. It is moderate in the Williams soil.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, crested wheatgrass, and smooth brome. Wheat, barley, and oats are the main crops. The dense claypan subsoil in the Noonan soil and the sodium in the Niobell and Noonan soils restrict crop growth by limiting root penetration and the rate of water intake. Measures that increase the rate of water intake, improve tilth, and conserve moisture in the Niobell and Noonan soils and that control erosion and conserve moisture in the Williams soil are the main management needs. Examples are leaving crop residue on the surface, minimizing tillage, and including grasses

and legumes in the cropping sequence. Chiseling or subsoiling improves tilth and increases the rate of water intake.

If these soils are used for range, the dense claypan subsoil in the Noonan soil limits productivity and the variety of suitable grasses. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth.

These soils are suited to windbreaks and environmental plantings, but the dense claypan subsoil in the Noonan soil is a limitation. Except for the species that require an abundant supply of moisture, all climatically suited trees and shrubs grow well on the Williams soil. Trees and shrubs can be established on the Niobell and Noonan soils, but optimum survival, growth, and vigor are unlikely.

These soils are suited to most kinds of building site development, but the moderate or high shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking or swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Niobell soil is in capability unit IIIs-1, Clayey range site, and windbreak suitability group 4L; the Noonan soil is in capability unit IVs-2, Claypan range site, and windbreak suitability group 9; the Williams soil is in capability unit IIe-2, Silty range site, and windbreak suitability group 3.

Ng—Nishon silt loam. This deep, poorly drained, level soil is on till plains. It is ponded during periods of snowmelt and after heavy rains. Areas are circular or irregularly shaped and range from 5 to 100 acres in size. Slopes are concave.

Typically, the surface layer is dark grayish brown silt loam about 4 inches thick. The subsurface layer is light gray silt loam about 4 inches thick. The subsoil is about 24 inches thick. The upper part is gray, very firm clay. The next part is gray, firm silty clay. The lower part is light brownish gray, firm, calcareous silty clay. The upper part of the underlying material is light gray, calcareous silty clay. The lower part to a depth of 60 inches is light brownish gray, calcareous clay loam.

Included with this soil in mapping are areas of Heil, Miranda, and Tonka soils. These soils make up less than 10 percent of this map unit. Heil and Tonka soils are in positions on the landscape similar to those of the Nishon soil. Tonka soils have a surface layer that is 8 to 15 inches thick. Heil and Miranda soils have a sodium-affected subsoil. The moderately well drained and somewhat poorly drained Miranda soils are in the slightly higher positions on the landscape.

The content of organic matter is moderate in the Nishon soil, and fertility is medium. Tilth is poor. Permeability is slow. Available water capacity is moderate or high. A seasonal high water table is within a depth of 3 feet. As much as 1 foot of water ponds on the surface during some wet periods. Runoff is ponded. The shrink-swell potential is high.

Most of the acreage supports native grasses and is used for grazing or hay. Compaction and ponding are problems. Restricted grazing during wet periods helps to prevent compaction and puddling, both of which result in an increase in the extent of the less desirable grasses and of weeds. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity. Many areas are potential sites for excavated ponds.

Many areas are cultivated along with the adjacent areas. This soil is poorly suited to cultivated crops and to tame pasture and hay. The choice of suitable tame pasture plants is limited to water-tolerant species, such as Garrison creeping foxtail and reed canarygrass. Ponding is a hazard. Crops are commonly drowned out. Measures that improve drainage, increase the rate of water intake, and improve tilth are the main management needs. Suitable drainage outlets generally are not available. Chiseling or subsoiling and a cropping sequence that includes grasses and legumes improve tilth and increase the rate of water intake.

This soil is generally unsuited to windbreaks and environmental plantings unless it is drained. It is generally unsuited to building site development and septic tank absorption fields because of the ponding.

This soil is in capability unit IVw-1, Closed Depression range site, and windbreak suitability group 10.

Nh—Nishon-Heil silt loams. These deep, poorly drained, level soils are on till plains. They are ponded during periods of snowmelt or heavy rainfall. The Heil soil is slightly higher on the landscape than the Nishon soil. Areas are irregular in shape and range from 5 to 100 acres in size. They are 45 to 55 percent Nishon soil and 35 to 45 percent Heil soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Nishon soil is dark grayish brown silt loam about 4 inches thick. The subsurface layer is light gray silt loam about 4 inches

thick. The subsoil is about 24 inches thick. The upper part is gray, very firm clay. The next part is gray, firm silty clay. The lower part is light brownish gray, firm, calcareous silty clay. The upper part of the underlying material is light gray, calcareous silty clay. The lower part to a depth of 60 inches is light brownish gray, calcareous clay loam.

Typically, the surface layer of the Heil soil is gray silt loam about 2 inches thick. The subsoil is dark gray, very firm silty clay about 33 inches thick. The underlying material to a depth of 60 inches is gray and light gray, calcareous clay loam.

Included with these soils in mapping are small areas of Miranda, Parnell, and Tonka soils. These included soils make up less than 10 percent of this map unit. The moderately well drained Miranda soils are on toe slopes. The very poorly drained Parnell soils are in the slightly lower positions on the landscape. Tonka soils have a surface layer that is 8 to 15 inches thick. They are in positions on the landscape similar to those of the Nishon soil.

The content of organic matter is moderate in the Nishon and Heil soils, and fertility is medium. The Heil soil has a sodium-affected subsoil. Tilth is poor in both soils. Permeability is slow in the Nishon soil and very slow in the Heil soil. Available water capacity is moderate or high in the Nishon soil and moderate in the Heil soil. The water table is within a depth of 3 feet in the Nishon soil and within a depth of 1 foot in the Heil soil. As much as 1 foot of water ponds on both soils during some wet periods. Runoff is ponded. The shrink-swell potential is high.

Most of the acreage supports native grasses and is used for grazing. If these soils are used for range, the ponding is a hazard. The sodium-affected subsoil in the Heil soil also is a limitation. Surface compaction is a problem during wet periods. Restricted grazing during these periods helps to prevent compaction and puddling, both of which result in an increase in the extent of the less desirable grasses and of weeds. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity. Many areas are potential sites for excavated ponds.

A few areas are cultivated along with the adjacent areas. These soils are poorly suited to cultivated crops and to tame pasture and hay. No crops grow well on the Heil soil. Examples of suitable pasture plants are Garrison creeping foxtail, western wheatgrass, and reed canarygrass. The dense, compact subsoil in the Heil soil and the ponding on both soils are the main limitations. Crops commonly are drowned out. Measures that improve drainage, increase the rate of water intake, and improve tilth are the main management needs. Suitable drainage outlets generally are not available. Chiseling or subsoiling and a cropping sequence that includes grasses and legumes improve tilth and increase the rate of water intake.

These soils are generally unsuited to windbreaks and environmental plantings. The ponding on both soils and the dense, compact subsoil in the Heil soil severely limit the growth and survival of trees and shrubs.

These soils are generally unsuited to building site development and septic tank absorption fields because of the ponding.

The Nishon soil is in capability unit IVw-1, Closed Depression range site, and windbreak suitability group 10; the Heil soil is in capability unit VIw-4, Closed Depression range site, and windbreak suitability group 10.

No—Noonan-Niobell-Miranda loams. These deep, level and gently undulating, moderately well drained soils are on till plains. Slopes are 0 to 3 percent. The Niobell soil is on back slopes, the Noonan soil is on the upper foot slopes, and the Miranda soil is on the lower foot slopes. Areas are irregular in shape and range from 10 to 800 acres in size. They are 30 to 40 percent Noonan soil, 25 to 35 percent Niobell soil, and 15 to 25 percent Miranda soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Noonan soil is dark grayish brown loam about 7 inches thick. The subsurface layer is grayish brown loam about 2 inches thick. The subsoil is clay loam about 45 inches thick. The upper part is dark grayish brown and firm. The next part is light olive brown and friable. It has nests of gypsum and other salts. The lower part is light brownish gray, friable, and calcareous. The underlying material to a depth of 60 inches is light brownish gray, calcareous clay loam. In places the subsoil contains more clay.

Typically, the surface layer of the Niobell soil is dark grayish brown loam about 8 inches thick. The subsurface layer is grayish brown loam about 2 inches thick. Below this is a transitional layer of dark grayish brown and light brownish gray clay loam about 6 inches thick. The subsoil is grayish brown, yellowish brown, and light yellowish brown, friable clay loam about 30 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is pale yellow, calcareous clay loam. In places the subsoil contains more clay.

Typically, the surface layer of the Miranda soil is gray loam about 4 inches thick. The subsoil is firm clay loam about 25 inches thick. The upper part is grayish brown and dark grayish brown. The next part is light olive brown and has nests of gypsum and other salts. The lower part is light yellowish brown, is calcareous, and

has nests of salt and gypsum. The underlying material to a depth of 60 inches is light brownish gray and light yellowish brown, calcareous clay loam.

Included with these soils in mapping are small areas of Heil, Nishon, and Williams soils. These included soils make up less than 15 percent of this map unit. The poorly drained Heil and Nishon soils are in basins. The well drained Williams soils do not have a sodium-affected subsoil. They are slightly higher on the landscape than the Noonan, Niobell, and Miranda soils.

The content of organic matter is moderate in the Noonan, Niobell, and Miranda soils. Fertility is medium in the Noonan and Niobell soils and low or medium in the Miranda soil. All three soils have a sodium-affected subsoil. Tilth is poor in the Noonan and Miranda soils and good in the Niobell soil. Permeability is slow in the Noonan and Niobell soils and very slow in the Miranda soil. Available water capacity is moderate in the Noonan and Miranda soils and moderate or high in the Niobell soil. Runoff is slow on all three soils. The shrink-swell potential is high in the subsoil of the Noonan and Niobell soils and moderate in the underlying material. It is moderate in the Miranda soil.

Most of the acreage supports native grasses and is used for grazing. This map unit is suited to range, but the dense claypan subsoil in the Noonan and Miranda soils limits productivity and the variety of suitable grasses. Surface compaction is a major problem on the Noonan and Miranda soils. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This map unit is poorly suited to cultivated crops and to tame pasture and hay. No crops grow well on the Miranda soil. Examples of suitable pasture plants are alfalfa, crested wheatgrass, intermediate wheatgrass, and pubescent wheatgrass. Wheat, barley, and oats are the main crops. The dense claypan subsoil in the Noonan and Miranda soils and the sodium in all three soils restrict crop growth by limiting root penetration and the rate of water intake. Measures that conserve moisture, increase the rate of water intake, and improve tilth are the main management needs. Examples are tillage practices that leave crop residue on the surface, a cropping sequence that includes grasses and legumes, and timely tillage. Chiseling or subsoiling increases the rate of water intake and improves tilth.

The Noonan and Niobell soils are suited to windbreaks and environmental plantings, but the Miranda soil is generally unsuited. The sodium-affected subsoil in all three soils and the high content of salts in the Miranda soil are limitations. Trees and shrubs can be established on the Niobell and Noonan soils, but optimum growth, survival, and vigor are unlikely. No trees or shrubs grow well on the Miranda soil.

These soils are suited to most kinds of building site development, but the moderate or high shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. The absorption fields generally do not function well unless they are significantly enlarged.

The Noonan soil is in capability unit IVs-2, Claypan range site, and windbreak suitability group 9; the Niobell soil is in capability unit IIIs-1, Clayey range site, and windbreak suitability group 4L; the Miranda soil is in capability unit VIs-1, Thin Claypan range site, and windbreak suitability group 10.

Og—Orthents, gravelly. These soils are in areas that have been excavated, filled, or graded. The original soil features have been destroyed. Areas are irregular in shape and range from 5 to 150 acres in size. Slopes are nearly level and smooth.

Typically, excavated areas are a mixture of loamy and clayey, calcareous material. In areas that have been filled, earth, trash, or cinders were used. The fill material generally ranges from 2 to more than 5 feet thick. Some areas have been shaped for a special purpose.

Included with these soils in mapping are small areas of Urban land. The Urban land is covered by streets, parking lots, buildings, and other structures that so obscure or alter the soils that identification of the soil series is not feasible.

These soils are in capability unit VIIIs-2; no range site or windbreak suitability group is assigned.

Ot—Orthents, loamy. This map unit consists of open excavations that range from 5 to 30 feet deep. They are irregularly shaped or rectangular and range from 5 to 100 acres in size. Slopes are short and smooth. They range from nearly level on the bottoms of the excavations to very steep on the sides. Some of the bottoms are covered with water.

Typically, the surface layer is clay loam or silt loam. The underlying material is clay loam glacial till or varved lacustrine silt loam. In places a thin layer of partly decomposed organic material is at the surface.

Most areas are used only as a source of fill material for construction purposes. Some areas provide limited wildlife habitat. Abandoned excavations can be restored

to range, tame pasture, or cropland if reclamation measures can be applied. These measures include shaping the areas and applying a topsoil dressing. Applying fertilizer as needed helps to establish range and pasture grasses.

These soils are in capability unit VIIe-3, Thin Upland range site, and windbreak suitability group 10.

Pa—Parnell silty clay loam. This deep, very poorly drained, level soil is on till plains in the uplands. It is ponded for long periods. Areas are circular and range from 3 to 120 acres in size. Slopes are concave.

Typically, the surface layer is dark gray silty clay loam about 8 inches thick. The subsoil is firm silty clay about 46 inches thick. The upper part is dark gray and gray. The lower part is light brownish gray and calcareous. The underlying material to a depth of 60 inches is light olive gray, calcareous silty clay loam.

Included with this soil in mapping are small areas of the poorly drained Tonka and Vallers soils. These soils make up less than 10 percent of this map unit. Tonka soils are in the slightly higher positions on the landscape. Vallers soils are on toe slopes.

The content of organic matter is high in the Parnell soil. Fertility also is high. Permeability is slow. Available water capacity is moderate or high. The seasonal high water table is within a depth of 2 feet during wet periods. As much as 2 feet of water may pond on the surface. Runoff is ponded. The shrink-swell potential is high.

Most of the acreage supports native grasses and is used for grazing or native hay. Surface compaction is a problem during wet periods. Restricted grazing during these periods helps to prevent compaction. Many areas are good sites for stock water dugouts.

This soil is generally unsuited to cultivated crops and to windbreaks and environmental plantings because of the ponding. It is suited to tame pasture and hay, but the choice of tame pasture plants is limited to water-tolerant grasses unless the soil is artificially drained. Garrison creeping foxtail and reed canarygrass are examples.

This soil is generally unsuited to building site development and septic tank absorption fields because of the ponding.

This soil is in capability unit Vw-4, Shallow Marsh range site, and windbreak suitability group 10.

Pc—Parnell silty clay loam, ponded. This deep, very poorly drained, level soil is on till plains. It is ponded most of the year. Areas are circular or oblong and range from 5 to 100 acres in size.

Typically, the surface layer is dark gray silty clay loam about 8 inches thick. The subsoil is firm silty clay about 46 inches thick. The upper part is dark gray and gray. The lower part is light brownish gray and calcareous. The underlying material to a depth of 60 inches is light olive gray, calcareous silty clay loam.

Included with this soil in mapping are small areas of the poorly drained Vallers soils on toe slopes between and around the basins. These soils make up less than 10 percent of this map unit.

The content of organic matter is high in the Parnell soil. Fertility also is high. Permeability is slow. Available water capacity is moderate or high. The seasonal high water table is within a depth of 2 feet. As much as 2 feet of water ponds on the surface during some wet periods. Runoff is ponded. The shrink-swell potential is high.

Most areas support native vegetation and are used as wetland wildlife habitat. Deer, pheasants, and other wildlife frequent the margins of these areas. The native vegetation, which includes cattails, rushes, and sedges, provides food and cover for a variety of waterfowl and wetland birds. Ducks nest on the drier adjacent sites and raise their young in the ponded areas. Geese and other waterfowl use these areas as periodic resting and feeding sites during migration. The vegetated areas commonly are interspersed with small bodies of open water.

Because of the ponding, this soil is generally unsuited to cultivated crops, tame pasture and hay, windbreaks and environmental plantings, building site development, and septic tank absorption fields.

This soil is in capability unit VIIIw-1 and windbreak suitability group 10. No range site is assigned.

PeA—Peever clay loam, 0 to 2 percent slopes. This deep, well drained, level and nearly level soil is on till plains. Areas are irregular in shape and range from 5 to 60 acres in size. Slopes are long and smooth.

Typically, the surface layer is dark gray clay loam about 7 inches thick. The subsoil is firm clay loam about 36 inches thick. It is dark grayish brown in the upper part and light brownish gray and calcareous in the lower part. The underlying material to a depth of 60 inches is grayish brown, calcareous clay loam. In places the subsoil contains less clay.

Included with this soil in mapping are small areas of Cavour, Cresbard, and Tonka soils. These soils make up less than 15 percent of this map unit. Cavour and Cresbard soils have a sodium-affected subsoil. They are slightly lower on the landscape than the Peever soil. The poorly drained Tonka soils are in basins.

The content of organic matter is moderate in the Peever soil, and fertility is medium. Tilth is fair. Permeability is moderately slow or slow. Available water capacity is moderate or high. Runoff is slow. The

shrink-swell potential is high.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, barley, and oats are the main crops. Conserving moisture, improving tilth, and increasing the rate of water intake are the main management concerns. Tillage practices that leave crop residue on the surface conserve moisture and improve tilth. Chiseling or subsoiling increases the rate of water intake.

If this soil is used for range, compaction is a problem during wet periods. Restricted grazing during these periods helps to prevent compaction and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to windbreaks and environmental plantings. It takes in water slowly, however, and the clayey subsoil can restrict the penetration of tree roots. Windbreaks can be established, but optimum growth is unlikely.

This soil is suited to building site development, but the high shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

This soil is suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

This soil is in capability unit IIs-1, Clayey range site, and windbreak suitability group 4L.

PfB—Peever-Buse clay loams, 1 to 4 percent slopes. These deep, well drained, gently undulating and undulating soils are on till plains. The Peever soil is on back slopes, and the Buse soil is on shoulder slopes. Areas are irregular in shape and range from 5 to 100 acres in size. They are 55 to 65 percent Peever soil and 20 to 30 percent Buse soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Peever soil is dark gray clay loam about 7 inches thick. The subsoil is firm clay loam about 36 inches thick. It is dark grayish brown in the upper part and light brownish gray and calcareous in the lower part. The underlying material to a depth of 60 inches is grayish brown, calcareous clay loam. In places the subsoil contains less clay.

Typically, the surface layer of the Buse soil is dark gray, calcareous clay loam about 7 inches thick. The subsoil is pale brown, firm, calcareous clay loam about 15 inches thick. The underlying material to a depth of 60 inches is light yellowish brown, calcareous clay loam.

Included with these soils in mapping are small areas of Cavour, Ferney, and Tonka soils. These included soils make up less than 15 percent of this map unit. Cavour and Ferney soils have a sodium-affected subsoil. They are on foot slopes. The poorly drained Tonka soils are in basins.

The content of organic matter is moderate in the Peever soil and moderate to low in the Buse soil. Fertility is medium in the Peever soil and medium or low in the Buse soil. Tilth is fair in both soils. Permeability is moderately slow or slow in the Peever soil and moderately slow in the Buse soil. Available water capacity is moderate or high in both soils. Runoff is medium. The shrink-swell potential is high in the Peever soil and moderate in the Buse soil.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, barley, and oats are the main crops. Lime near the surface of the Buse soil restricts the availability of plant nutrients. Measures that control erosion, conserve moisture, improve fertility and tilth, and increase the rate of water intake are the main management needs. Minimum tillage or tillage practices that leave crop residue on the surface and a cropping sequence that includes grasses and legumes conserve moisture, help to control erosion, improve tilth, and help to maintain fertility. Chiseling or subsoiling increases the rate of water intake.

If these soils are used for range, compaction is a problem during wet periods. Restricted grazing during these periods helps to prevent compaction and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings. The Peever soil takes in water slowly and has a clayey subsoil that can restrict the penetration of tree roots. The high content of lime in the Buse soil is a limitation. Trees and shrubs can be established on both soils, but optimum survival, growth, and vigor are unlikely.

These soils are suited to building site development, but the shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Peever soil is in capability unit IIIe-3, Clayey range site, and windbreak suitability group 4L; the Buse soil is in capability unit IIIe-12, Thin Upland range site, and windbreak suitability group 8.

Pg—Pits, gravel. This map unit consists of open excavations, 5 to 30 feet deep, from which sand and gravel are being removed. Areas are irregular in shape and range from 5 to 15 acres in size. Slopes are uneven and broken. They range from nearly level on the bottom of the pits to almost vertical on the rims. Water covers the bottom of some of the pits.

The bottoms of the pits typically are sand and gravel, but they are loam or clay loam glacial till in areas where all of the sand and gravel has been removed. Mounds of mixed cobbly, stony, and loamy overburden are along the edges of the pits. The bottoms and sides support little or no vegetation during periods when the pits are used.

Included in mapping are small areas of Wabek Variant soils. These soils have gravelly sand at a depth of 7 to 14 inches. They support plants.

Most of the pits can be used only as a source of sand and gravel for construction purposes. Some provide limited wildlife habitat. Abandoned gravel pits can be restored to range, tame pasture, or cropland if reclamation measures are applied. These measures include shaping the areas and using the mounds of overburden material as topsoil dressing. Applying fertilizer as needed helps to establish range or pasture.

This map unit is in capability unit VIIIs-2 and windbreak suitability group 10. No range site is assigned.

Pm—Playmoor silty clay loam. This deep, poorly drained, level and nearly level soil is on flood plains. It is frequently flooded for brief periods in spring and after heavy rains. Areas are irregular in shape and range from 10 to 200 acres in size. Slopes are smooth or slightly concave.

Typically, the surface layer is calcareous silty clay loam about 10 inches thick. It is dark gray in the upper part and gray in the lower part. The subsoil is gray, calcareous silty clay loam about 39 inches thick. The underlying material to a depth of 60 inches is stratified gray and light gray, calcareous, sandy loam and loamy sand. Salts are throughout the profile to a depth of 49 inches.

Included with this soil in mapping are small areas of LaDelle, Lamoure, Ludden, and Ryan soils. These soils make up less than 15 percent of this map unit. LaDelle and Lamoure soils have a lower content of visible salts throughout than the Playmoor soil. The moderately well drained LaDelle soils do not have lime near the surface. They are slightly higher on the landscape than the Playmoor soil. Lamoure soils are in positions on the landscape similar to those of the Playmoor soil. Ludden soils contain more clay and less salt than the Playmoor soil. Also, they are in slightly lower positions on the landscape. Ryan soils have a sodium-affected subsoil. They are in the lower positions on the landscape.

The content of organic matter is high in the Playmoor soil, and fertility is medium. Permeability is moderate or moderately slow. Available water capacity is high. The water table is at a depth of 0.5 foot to 3.5 feet during part of the growing season. Runoff is slow or very slow. The shrink-swell potential is moderate.

Most areas are cultivated along with the surrounding areas. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are tall wheatgrass, western wheatgrass, reed canarygrass, and Garrison creeping foxtail. Corn, wheat, barley, and oats are the main crops. The high content of salts and the wetness limit productivity. The main management concerns are the wetness, salinity, and the hazard of wind erosion. A protective cover of crop residue, green manure crops, and timely tillage help to control wind erosion and maintain tilth and fertility. In some areas open drains can be used to remove excess water.

If this soil is used for range, compaction is a problem during wet periods. The high content of salts reduces the vigor of all species that are not tolerant of salt. Grazing when the soil is wet causes surface compaction and puddling, both of which result in a decrease in the extent of desirable grasses. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is generally unsuited to windbreaks and environmental plantings because of the flooding, the high water table, and the excess salts.

This soil is generally unsuited to building site development and sanitary facilities because of the wetness and the flooding.

This soil is in capability unit IVw-4, Saline Subirrigated range site, and windbreak suitability group 10.

Pr—Playmoor-Lamoure silty clay loams, channeled. These deep, poorly drained, level and nearly level soils are on flood plains that are dissected by stream channels. They are frequently flooded for brief periods. The Playmoor soil is on the lower flood plains, and the Lamoure soil is on the higher flood

plains. Areas are long and narrow and range from 25 to more than 1,000 acres in size. They are 45 to 60 percent Playmoor soil and 25 to 40 percent Lamoure soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Playmoor soil is calcareous silty clay loam about 10 inches thick. It is dark gray in the upper part and gray in the lower part. The subsoil is gray, calcareous silty clay loam about 39 inches thick. The underlying material to a depth of 60 inches is stratified gray and light gray, calcareous sandy loam and loamy sand. Salts are throughout the profile to a depth of 49 inches. In places the soil is dark to a depth of less than 24 inches.

Typically, the surface layer of the Lamoure soil is dark gray, calcareous silty clay loam about 7 inches thick. The subsurface layer is calcareous silty clay loam about 29 inches thick. It is dark gray in the upper part and gray in the lower part. The underlying material is gray, calcareous silty clay loam about 4 inches thick. The next 5 inches is dark gray, calcareous silty clay loam. Below this to a depth of 60 inches is white, calcareous loamy very fine sand. In places the dark surface soil is less than 24 inches thick.

Included with these soils in mapping are small areas of Dovray, Harriet, and LaDelle soils. These included soils make up less than 15 percent of this map unit. Dovray soils contain more clay than the Playmoor and Lamoure soils. They are in old channels and on the lower parts of the landscape. Harriet soils have a sodium-affected subsoil. They are on the slightly lower parts of the landscape. The moderately well drained LaDelle soils are on the slightly higher terraces.

The content of organic matter is high in the Playmoor and Lamoure soils. Fertility is medium in the Playmoor soil and medium or high in the Lamoure soil. Permeability is moderate or moderately slow in both soils. Available water capacity is high. The water table is at a depth of 0.5 foot to 3.5 feet during part of the growing season in the Playmoor soil. It is within a depth of 2 feet early in the growing season in the Lamoure soil. Runoff is slow or very slow on the Playmoor soil and slow on the Lamoure soil. The shrink-swell potential is moderate in both soils.

Most of the acreage is used for grazing or native hay. Grazing when the soils are wet causes surface compaction and puddling, both of which result in a decrease in the extent of desirable grasses. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

Because of the meandering channels and the flooding, these soils are generally unsuited to cultivated crops. They are suited to tame pasture and hay in areas that are accessible to farm machinery, but the high content of salts in the Playmoor soil and the flooding on both soils limit the choice of suitable species. Suitable species on the Playmoor soil include tall wheatgrass, western wheatgrass, reed canarygrass, and Garrison creeping foxtail. Suitable species on the Lamoure soil include alfalfa, Garrison creeping foxtail, intermediate wheatgrass, smooth brome, and reed canarygrass. Restricted grazing during wet periods helps to prevent surface compaction. Harvesting should be delayed until the soils are dry enough for equipment to be used without causing excessive compaction. Silt and debris deposited by floodwater damage pasture plants in some years and hinder harvesting.

The Playmoor soil is generally unsuited to windbreaks and environmental plantings because of the flooding, the high water table, and the excess salts. The Lamoure soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, and those that require an abundant supply of moisture grow especially well. Because of the meandering stream channels, however, they generally cannot be planted by machine. Hand planting may be necessary.

These soils are generally unsuited to building site development and sanitary facilities because of the wetness and the flooding.

The Playmoor soil is in capability unit VIw-1, Saline Subirrigated range site, and windbreak suitability group 10; the Lamoure soil is in capability unit VIw-1, Subirrigated range site, and windbreak suitability group 2W.

Ra—Ranslo silty clay loam. This deep, level, somewhat poorly drained soil is on terraces and flood plains. It is occasionally flooded for very brief periods. Areas are long and narrow or irregularly shaped and range from 25 to 100 acres in size. Slopes are smooth or slightly concave.

Typically, the surface layer is dark gray silty clay loam about 7 inches thick. The subsurface layer is gray loam about 3 inches thick. The subsoil is firm clay loam about 22 inches thick. The upper part is dark gray. The next part is grayish brown, is calcareous, and has nests of salt. The lower part is light olive gray and calcareous. The underlying material to a depth of 60 inches is light olive gray, calcareous clay loam.

Included with this soil in mapping are small areas of Harriet, LaDelle, Ludden, and Playmoor soils. These soils make up less than 15 percent of this map unit. The poorly drained Harriet, Ludden, and Playmoor soils are in the slightly lower positions on the landscape. LaDelle, Ludden, and Playmoor soils do not have a sodium-affected subsoil. The moderately well drained

LaDelle soils are in the slightly higher positions on the landscape.

The content of organic matter is high in the Ranslo soil, and fertility is medium. This soil has a sodium-affected subsoil. Tilth is poor. Permeability is slow. Available water capacity is moderate or high. The water table is at a depth of 1 to 3 feet during wet periods. Runoff is slow. The shrink-swell potential is high.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. It is better suited to small grain than to corn because of the dense claypan subsoil. Examples of suitable pasture plants are alfalfa, Garrison creeping foxtail, intermediate wheatgrass, and reed canarygrass. Wheat, barley, and oats are the main crops. Flooding is a hazard, and the dense claypan subsoil and the sodium restrict crop growth. Measures that improve tilth, increase the rate of water intake, and conserve moisture are the main management needs. Tillage practices that leave crop residue on the surface, chiseling or subsoiling, and a cropping sequence that includes grasses and legumes are examples.

If this soil is used for range, compaction is a problem. Grazing during wet periods causes compaction of the surface layer, which results in an increase in the extent of the less desirable grasses and of weeds. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees grow well.

Because of the wetness and the flooding, this soil is generally unsuited to building site development and septic tank absorption fields.

This soil is in capability unit IIIw-4, Subirrigated range site, and windbreak suitability group 2W.

Rc—Ranslo-Harriet loams. These deep, level soils are on flood plains that are occasionally flooded for very brief or long periods. A meandering stream channel dissects many areas. The somewhat poorly drained Ranslo soil is on the higher flood plains, and the poorly drained Harriet soil is on the lower flood plains. Areas are long and narrow and range from 20 to more than 600 acres in size. They are 40 to 50 percent Ranslo soil and 35 to 45 percent Harriet soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Ranslo soil is dark gray loam about 7 inches thick. The subsurface layer is gray loam about 3 inches thick. The subsoil is firm clay loam about 22 inches thick. The upper part is dark gray. The next part is grayish brown, is calcareous, and has nests of salt. The lower part is light olive gray and calcareous. The underlying material to a depth of 60 inches is light olive gray, calcareous clay loam. In places the subsoil contains less clay.

Typically, the surface layer of the Harriet soil is gray loam about 2 inches thick. The subsoil is dark gray and gray, calcareous clay loam about 24 inches thick. It is very firm in the upper part and firm in the lower part. It has nests of salt throughout. The underlying material to a depth of 60 inches is gray, calcareous clay loam. In places the subsoil does not have columnar structure.

Included with these soils in mapping are small areas of Brantford Variant and Miranda soils. These included soils make up less than 15 percent of this map unit. Brantford Variant soils have gravelly sand at a depth of 10 to 20 inches. They are on terraces. Miranda soils contain more sand and less clay in the subsoil than the Harriet and Ranslo soils. They are on toe slopes.

The content of organic matter is high in the Ranslo soil and moderate in the Harriet soil. Fertility is medium in the Ranslo soil and low or medium in the Harriet soil. Both soils have a sodium-affected subsoil. Tilth is poor. Permeability is slow in the Ranslo soil and very slow in the Harriet soil. Available water capacity is moderate or high in the Ranslo soil and moderate in the Harriet soil. During wet periods the water table is at a depth of 1 to 3 feet in the Ranslo soil and is within a depth of 1 foot in the Harriet soil. Runoff is slow on both soils. The shrink-swell potential is high.

Most of the acreage supports native grasses and is used for grazing. Surface compaction is a major problem on the Harriet soil. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are generally unsuited to cultivated crops and to windbreaks and environmental plantings because of the wetness and the high content of salts in the subsoil of the Harriet soil.

These soils are suited to tame pasture and hay, but the choice of pasture plants is limited because of wetness in the sodium-affected subsoil. The best suited pasture plants are Garrison creeping foxtail, reed canarygrass, tall wheatgrass, and western wheatgrass.

These soils are generally unsuited to building site development and septic tank absorption fields because of the wetness and the flooding.

The Ranslo soil is in capability unit Vw-1, Subirrigated range site, and windbreak suitability group 10; the Harriet soil is in capability unit VIs-6, Saline Lowland range site, and windbreak suitability group 10.

RfA—Renshaw-Fordville loams, 0 to 2 percent slopes. These level and nearly level soils are on outwash plains and terraces. The somewhat excessively

drained Renshaw soil is shallow over gravelly sand. It is on back slopes. The well drained Fordville soil is moderately deep over gravelly sand. It is on foot slopes. Areas of this map unit are irregular in shape and range from 10 to 150 acres in size. They are 55 to 65 percent Renshaw soil and 20 to 30 percent Fordville soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Renshaw soil is dark gray loam about 6 inches thick. The subsoil is dark grayish brown, very friable sandy clay loam about 9 inches thick. The underlying material to a depth of 60 inches is light brownish gray and very pale brown gravelly coarse sand.

Typically, the surface layer of the Fordville soil is dark gray loam about 8 inches thick. The subsoil is dark grayish brown and brown, friable clay loam about 16 inches thick. The underlying material to a depth of 60 inches is pale brown, calcareous gravelly sand.

Included with these soils in mapping are small areas of Divide and Spottswood soils. These included soils make up less than 15 percent of this map unit. They are in the slightly lower positions on the landscape. The somewhat poorly drained Divide soils have free lime at or near the surface. The moderately well drained Spottswood soils have accumulations of lime in the lower part of the subsoil. Also included, on the higher convex parts of the landscape, are areas of soils that have gravelly sand within a depth of 14 inches.

The content of organic matter is moderate in the Renshaw and Fordville soils. Fertility is medium or low in the Renshaw soil and medium in the Fordville soil. Available water capacity is low in the Renshaw soil and low or moderate in the Fordville soil. Permeability is moderate or moderately rapid in the subsoil of the Renshaw soil and rapid or very rapid in the underlying material. It is moderate in the subsoil of the Fordville soil and rapid in the underlying material. Runoff is slow on both soils. The shrink-swell potential is low.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay, but they are droughty because the rooting depth is limited by the underlying gravelly material. Alfalfa, intermediate wheatgrass, and pubescent wheatgrass are examples of suitable pasture plants. Wheat, oats, and corn are the main crops. Measures that conserve moisture are the main management needs. Minimizing tillage and leaving crop residue on the surface conserve moisture. The soils are well suited to irrigation.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings, but the droughtiness is a limitation. No trees or shrubs grow well. They can be established, but optimum growth, survival, and vigor are unlikely.

These soils are suited to most kinds of building site development, but the sides of shallow excavations tend to cave in unless they are shored. The soils readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. The soils are a probable source of sand and gravel for road construction.

The Renshaw soil is in capability unit IVs-1, Shallow to Gravel range site, and windbreak suitability group 6G; the Fordville soil is in capability unit IIIs-2, Silty range site, and windbreak suitability group 6G.

RfB—Renshaw-Fordville loams, 2 to 6 percent slopes. These gently sloping soils are on outwash plains and terraces. The somewhat excessively drained Renshaw soil is shallow over gravelly coarse sand. It is on back slopes. The well drained Fordville soil is moderately deep over gravelly sand. It is on foot slopes. Areas of this map unit are irregular in shape and range from 10 to 150 acres in size. They are 55 to 65 percent Renshaw soil and 20 to 30 percent Fordville soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Renshaw soil is dark gray loam about 6 inches thick. The subsoil is dark grayish brown, very friable sandy clay loam about 9 inches thick. The underlying material to a depth of 60 inches is light brownish gray and very pale brown gravelly coarse sand.

Typically, the surface layer of the Fordville soil is dark gray loam about 8 inches thick. The subsoil is dark grayish brown and brown, friable clay loam about 16 inches thick. The underlying material to a depth of 60 inches is pale brown, calcareous gravelly sand.

Included with these soils in mapping are small areas of Divide and Spottswood soils. These included soils make up less than 15 percent of this map unit. They are on the slightly lower parts of the landscape. The somewhat poorly drained Divide soils have free lime at or near the surface. The moderately well drained Spottswood soils have accumulations of lime in the lower part of the subsoil. Also included, on the higher convex parts of the landscape, are areas of soils that have gravelly sand within a depth of 14 inches.

The content of organic matter is moderate in the Renshaw and Fordville soils. Fertility is medium or low in the Renshaw soil and medium in the Fordville soil. Available water capacity is low in the Renshaw soil and low or moderate in the Fordville soil. Permeability is

moderate or moderately rapid in the subsoil of the Renshaw soil and rapid or very rapid in the underlying material. It is moderate in the subsoil of the Fordville soil and rapid in the underlying material. Runoff is medium or slow on both soils. The shrink-swell potential is low.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay, but they are droughty because of the underlying gravelly material. Alfalfa, intermediate wheatgrass, and pubescent wheatgrass are examples of suitable pasture plants. Wheat, oats, and corn are the main crops. Measures that conserve moisture and control erosion are the main management needs. Examples are tillage practices that leave crop residue on the surface and minimum tillage. Grassed waterways help to keep gullies from forming. The soils are well suited to irrigation.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings, but the droughtiness is a limitation. No trees or shrubs grow well. They can be established, but optimum growth, survival, and vigor are unlikely.

These soils are suited to most kinds of building site development, but the sides of shallow excavations tend to cave in unless they are shored. The soils readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. The soils are a probable source of sand and gravel for road construction.

The Renshaw soil is in capability unit IVe-6, Shallow to Gravel range site, and windbreak suitability group 6G; the Fordville soil is in capability unit IIIe-6, Silty range site, and windbreak suitability group 6G.

Ry—Ryan-Ludden complex. These deep, poorly drained, level soils are on flood plains. The Ryan soil is on the lower flood plains, and the Ludden soil is on the higher flood plains. The Ryan soil is occasionally flooded for brief to long periods, and the Ludden soil is frequently flooded for brief to long periods. Areas are irregular in shape and range from 15 to more than 300 acres in size. They are 50 to 60 percent Ryan soil and 25 to 35 percent Ludden soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Ryan soil is gray silty clay loam about 2 inches thick. The subsoil is about 52 inches thick. The upper part is dark gray, very firm clay. The next part is dark gray, very firm, calcareous clay that has nests of salt. The lower part is gray, firm, calcareous clay that has nests of salt. The underlying material to a depth of 60 inches is gray, calcareous silty clay loam that has nests of salt.

Typically, the surface layer of the Ludden soil is dark gray, calcareous silty clay about 8 inches thick. The subsoil is dark gray, firm, calcareous silty clay about 29 inches thick. The underlying material to a depth of 60 inches is gray, calcareous silty clay and clay loam. In some places carbonates are farther from the surface. In other places visible salts are throughout the soil.

Included with these soils in mapping are small areas of Lamoure and Playmoor soils. These included soils make up less than 15 percent of this map unit. They contain more silt and less clay than the Ryan and Ludden soils. They are in the slightly higher positions on the landscape.

The content of organic matter is moderate or high in the Ryan soil and high in the Ludden soil. Fertility is medium in both soils. The Ryan soil has a sodium-affected subsoil. Tilth is poor in both soils. Permeability is very slow in the Ryan soil and slow in the Ludden soil. Available water capacity is moderate in the Ryan soil and moderate or high in the Ludden soil. During wet periods the water table is within a depth of 1 foot in the Ryan soil and within a depth of 2 feet in the Ludden soil. Runoff is very slow on the Ryan soil and slow or very slow on the Ludden soil. The shrink-swell potential is high in both soils.

About half of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are tall wheatgrass, intermediate wheatgrass, reed canarygrass, and Garrison creeping foxtail. Wheat, barley, and oats are the main crops. The flooding and the high water table are limitations. Also, the dense claypan subsoil and the content of sodium in the Ryan soil and the excess lime in the surface layer of the Ludden soil restrict crop growth by limiting root penetration, the rate of water intake, and the availability of plant nutrients. The main management concerns are reducing wetness, improving tilth, increasing the rate of water intake, and maintaining fertility. Returning crop residue to the soil and delaying tillage during wet periods help to prevent deterioration of tilth. Diverting runoff from the adjacent soils and installing a drainage system reduce the wetness. Tillage practices that leave crop residue on the surface, chiseling or subsoiling, and a cropping sequence that includes grasses and legumes increase the rate of water intake and improve fertility.

No major hazards or limitations affect the use of these soils for range, but compaction is a problem

during wet periods. Restricted grazing during these periods helps to prevent compaction and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are generally unsuited to windbreaks and environmental plantings because of the dense claypan subsoil, the high content of salts, and the wetness. They are generally unsuited to building site development and septic tank absorption fields because of the wetness and the flooding.

The Ryan soil is in capability unit IVs-4, Thin Claypan range site, and windbreak suitability group 10; the Ludden soil is in capability unit IVw-1, Wetland range site, and windbreak suitability group 10.

SaD—Serden fine sand, 6 to 15 percent slopes. This deep, excessively drained, moderately sloping and strongly sloping soil is on glacial lake plains. Active sand blowouts 10 to 300 feet in diameter are scattered throughout. Slopes are short and rounded, except where they are broken by the blowouts, which are mostly on the crests of ridges and knolls. Elevation varies by as much as 30 feet. Areas of this soil are irregular in shape and range from 20 to 350 acres in size.

Typically, the surface layer is dark gray fine sand about 6 inches thick. Below this is a mixed layer of dark grayish brown fine sand about 4 inches thick. The underlying material to a depth of 60 inches is grayish brown fine sand.

Included with this soil in mapping are small areas of Hamar, Hecla, Maddock, Ulen, and Venlo soils. These soils make up less than 15 percent of this map unit. The poorly drained and somewhat poorly drained Hamar soils are in basins. The moderately well drained Hecla soils are on foot slopes. Maddock soils have a dark surface layer that is thicker than that of the Serden soil. They are on back slopes. The moderately well drained and somewhat poorly drained Ulen soils are on toe slopes. They have free lime within a depth of 16 inches. The very poorly drained Venlo soils are in basins.

The content of organic matter is low in the Serden soil. Fertility also is low. Permeability is rapid. Available water capacity is low. Runoff is slow. The shrink-swell potential is low.

Most of the acreage supports native grasses and is used for grazing. The erosion hazard is severe unless an adequate plant cover is maintained. Reestablishing vegetation is difficult in denuded areas. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity. The risk of blowouts increases along overused livestock trails and around watering facilities.

This soil is generally unsuited to cultivated crops, tame pasture and hay, and windbreaks and environmental plantings because of the hazard of wind erosion and the low available water capacity.

This soil is suited to building site development, but the sides of shallow excavations tend to cave in unless they are shored. Land shaping is necessary in the more sloping areas. The soil is generally unsuited to septic tank absorption fields because it does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water.

This soil is in capability unit VIe-7, Sands range site, and windbreak suitability group 10.

ScB—Serden-Hamar-Venlo loamy fine sands, 0 to 6 percent slopes. These deep, level to undulating, sandy soils are on glacial lake plains. The excessively drained Serden soil is on shoulder slopes, the somewhat poorly drained Hamar soil is on toe slopes, and the very poorly drained Venlo soil is in basins. Areas are irregular in shape and range from 50 to 400 acres in size. They are 40 to 55 percent Serden soil, 15 to 30 percent Hamar soil, and 10 to 20 percent Venlo soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Serden soil is dark gray loamy fine sand about 6 inches thick. The next layer is dark grayish brown fine sand about 4 inches thick. The underlying material to a depth of 60 inches is grayish brown fine sand.

Typically, the surface layer of the Hamar soil is dark gray loamy fine sand about 7 inches thick. The subsurface layer is dark gray, mottled loamy fine sand about 10 inches thick. The underlying material to a depth of 60 inches is grayish brown, mottled fine sand. It is calcareous in the lower part.

Typically, the surface layer of the Venlo soil is very dark gray loamy fine sand about 10 inches thick. The underlying material to a depth of 60 inches is light olive gray, light gray, and gray, mottled fine sand. In places carbonates are at or near the surface.

Included with these soils in mapping are small areas of Hecla, Maddock, and Ulen soils. These included soils make up less than 20 percent of this map unit. The moderately well drained Hecla soils are slightly higher on the landscape than the Hamar soil. The well drained Maddock soils are on back slopes. Ulen soils have a buildup of carbonates within a depth of 16 inches. They are on the lower toe slopes.

The content of organic matter is low in the Serden

soil and moderate in the Hamar and Venlo soils. Fertility is low in the Serden soil, medium in the Hamar soil, and low or medium in the Venlo soil. Permeability is rapid in the Serden and Venlo soils and moderately rapid or rapid in the Hamar soil. Available water capacity is low in the Serden and Venlo soils. It is low or moderate in the Hamar soil. The Hamar and Venlo soils have a seasonal high water table within a depth of 2 feet during wet periods. Runoff is slow on the Serden and Hamar soils and very slow on the Venlo soil. The shrink-swell potential is low in all three soils.

Most of the acreage supports native grasses and is used for grazing. The erosion hazard is severe unless an adequate plant cover is maintained. Reestablishing vegetation is difficult in denuded areas. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity. The risk of blowouts increases along overused livestock trails and around watering facilities.

These soils are generally unsuited to cultivated crops because of the severe hazard of wind erosion and the low available water capacity in the Serden soil and the wetness in the Hamar and Venlo soils. The Serden soil is generally unsuited to tame pasture and hay because of the hazard of wind erosion and the low available water capacity. The Hamar and Venlo soils are suited to tame pasture and hay, but the wetness limits the choice of pasture plants to water-tolerant species. Garrison creeping foxtail and reed canarygrass are examples.

The Serden soil is suited to windbreaks and environmental plantings, but the low available water capacity and the hazard of wind erosion are management concerns. No trees or shrubs grow well. Only evergreens can be successfully established. The Hamar soil is well suited to windbreaks and environmental plantings. All climatically suited species grow well on this soil, especially those that require an abundant supply of moisture. The Venlo soil is generally unsuited to windbreaks and environmental plantings because of the wetness. Planting the trees and shrubs directly in sod helps to control wind erosion.

The Serden soil is suited to most kinds of building site development, but the sides of shallow excavations tend to cave in unless they are shored. This soil is generally unsuited to septic tank absorption fields because it does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water. The Hamar and Venlo soils are unsuited to building site development and septic tank absorption fields because of the wetness.

The Serden soil is in capability unit VIe-7, Sands range site, and windbreak suitability group 7; the Hamar soil is in capability unit IVw-2, Subirrigated range site, and windbreak suitability group 2S; the Venlo soil is in capability unit Vw-3, Wetland range site, and windbreak suitability group 10.

Sd—Slickspots. This map unit consists of deep, level, very poorly drained soil material on till plains and glacial lake plains. It is ponded part of the year. Areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer ranges from fine sand to clay loam. It is crusted and contains many crystals and nests of salt. The underlying material is stratified fine sand to clay. In places a thin layer of partly decomposed organic material is at the surface.

A water table is at or near the surface most of the year. As much as 2 feet of water ponds on the surface during some wet periods.

Most areas support little or no vegetation. This map unit is unsuited to cultivated crops, tame pasture and hay, and windbreaks and environmental plantings. It is unsuitable as sites for buildings and sanitary facilities because of the ponding. Some areas are potential sites for excavated ponds.

This map unit is in capability unit VIIIs-3 and windbreak suitability group 10. No range site is assigned.

Sf—Spottswood-Divide loams, 0 to 2 percent slopes. These moderately well drained or somewhat poorly drained, level and nearly level soils are on outwash plains. They are moderately deep over gravelly sand. The Spottswood soil is on foot slopes, and the Divide soil is on toe slopes. Areas are irregular in shape and range from 10 to 200 acres in size. They are 50 to 70 percent Spottswood soil and 25 to 40 percent Divide soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Spottswood soil is dark gray loam about 7 inches thick. The subsoil is loam about 20 inches thick. The upper part is dark gray and dark grayish brown and is friable. The lower part is light gray, is calcareous, and has a few yellowish brown mottles. The underlying material to a depth of 60 inches is pale brown, calcareous gravelly sand.

Typically, the surface layer of the Divide soil is dark gray, calcareous loam about 8 inches thick. Below this is a transitional layer of gray, calcareous loam about 6 inches thick. The subsoil is white and light gray, calcareous loam about 12 inches thick. It has yellowish brown mottles in the lower part. The underlying material to a depth of 60 inches is yellowish brown, calcareous gravelly sand.

Included with these soils in mapping are small areas of Embden, Harmony Variant, and Renshaw soils.

These included soils make up less than 20 percent of this map unit. The well drained and moderately well drained Embden soils contain more sand in the subsoil than the Spottswood and Divide soils. Harmony Variant soils contain more clay in the subsoil than the Spottswood and Divide soils. Embden and Harmony Variant soils are in positions on the landscape similar to those of the Spottswood soil. Renshaw soils have gravelly sand at a depth of 14 to 20 inches. They are on back slopes.

The content of organic matter is moderate or high in the Spottswood soil and moderate in the Divide soil. Fertility is medium in both soils. Available water capacity is low or moderate. Permeability is moderate in the upper part of the Spottswood soil and rapid in the underlying gravelly sand. It is moderate in the upper part of the Divide soil and rapid or very rapid in the underlying gravelly sand. During wet periods, the Spottswood soil has a water table at a depth of 3.0 to 6.0 feet and the Divide soil has one at a depth of 2.5 to 5.0 feet. Runoff is slow on both soils. The shrink-swell potential is low.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Alfalfa, intermediate wheatgrass, and smooth brome are examples of suitable pasture plants. Wheat, barley, and oats are the main crops. Early maturing small grain grows better than other crops because the soils are droughty later in the growing season. A high content of lime restricts the availability of plant nutrients in the Divide soil. Measures that conserve moisture, control erosion, and maintain fertility are the main management needs. Leaving crop residue on the surface and including grasses and legumes in the cropping sequence are examples.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, and the species that require an abundant supply of moisture grow especially well.

These soils are suited to building site development, but the high water table is a limitation. Installing foundation drains and diverting runoff away from the buildings help to prevent the structural damage caused by wetness.

Septic tank absorption fields function poorly on these soils because of the high water table and a poor filtering capacity in the underlying gravelly sand. The poor filtering capacity can result in the pollution of ground water.

The Spottswood soil is in capability unit IIIs-2, Overflow range site, and windbreak suitability group 3; the Divide soil is in capability unit IIIs-4, Limy Subirrigated range site, and windbreak suitability group 1.

Sh—Stirum fine sandy loam. This deep, poorly drained, level soil is on glacial lake plains. Areas are irregular in shape and range from 10 to 100 acres in size.

Typically, the surface layer is very dark gray, calcareous fine sandy loam about 6 inches thick. The subsoil is friable, calcareous loam about 26 inches thick. The upper part is dark gray and light brownish gray, and the lower part is light gray. The underlying material to a depth of 60 inches is light gray, calcareous loamy very fine sand and loamy fine sand.

Included with this soil in mapping are small areas of Arveson, Fossum, Stirum Variant, and Ulen soils. These soils make up less than 15 percent of this map unit. Arveson, Fossum, and Ulen soils do not have a sodium-affected subsoil. Stirum Variant soils have a thin surface layer. Arveson, Fossum, and Stirum Variant soils are in the slightly lower positions on the landscape. Ulen soils are in the slightly higher positions.

The content of organic matter is moderate or high in the Stirum soil, and fertility is low. This soil has a sodium-affected subsoil. Tilth is poor. Permeability is moderately slow in the subsoil and moderate to rapid in the underlying material. Available water capacity is low or moderate. The water table is at a depth of 1 to 3 feet during wet periods, and water ponds on the surface for short periods. Runoff is very slow. The shrink-swell potential is low.

Most of the acreage supports native grasses and is used for grazing. Wetness can be a problem. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, crested wheatgrass, and pubescent wheatgrass. A high content of lime in the surface layer limits the availability of plant nutrients. The sodium-affected subsoil restricts root penetration. Measures that reduce wetness and improve fertility and tilth are the main management needs. Tillage practices that leave crop residue on the surface, a cropping sequence that includes grasses and legumes, and stripcropping improve fertility and tilth and help to control erosion. Other management needs are measures that increase the rate of water intake. Examples are chiseling and subsoiling. Suitable drainage outlets generally are not available.

This soil is suited to windbreaks and environmental plantings, but the sodium-affected subsoil and the ponding severely restrict growth. Optimum growth, survival, and vigor are unlikely.

This soil is unsuited to building site development and septic tank absorption fields because of the ponding.

This soil is in capability unit IVw-2, Subirrigated range site, and windbreak suitability group 9.

Sn—Stirum-Stirum Variant loams. These deep, poorly drained, level and nearly level soils are on glacial lake plains. The Stirum soil is on the upper toe slopes, and the Stirum Variant soil is on the lower toe slopes. Areas are irregular in shape and range from 10 to 100 acres in size. They are 40 to 50 percent Stirum soil and 35 to 45 percent Stirum Variant soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Stirum soil is very dark gray, calcareous loam about 6 inches thick. The subsoil is friable, calcareous loam about 26 inches thick. The upper part is dark gray and light brownish gray, and the lower part is light gray. The underlying material to a depth of 60 inches is light gray, calcareous loamy very fine sand and loamy fine sand.

Typically, the surface layer of the Stirum Variant soil is gray, calcareous loam about 1 inch thick. The subsoil is about 46 inches thick. The upper part is dark gray and light gray, calcareous loam. The next part is light gray, calcareous fine sandy loam that has nests of salt. The lower part is light gray, calcareous fine sandy loam. The underlying material to a depth of 60 inches is light gray fine sand.

Included with these soils in mapping are small areas of Borup, Ulen, and Wyndmere soils. These included soils make up less than 15 percent of this map unit. They do not have a sodium-affected subsoil. Borup soils contain more silt and less sand than the Stirum soil. They are in positions on the landscape similar to those of the Stirum soil. Ulen and Wyndmere soils contain more sand than the Stirum Variant soil. They are in positions on the landscape similar to those of the Stirum Variant soil.

The content of organic matter is moderate or high in the Stirum soil and moderate in the Stirum Variant soil. Fertility is low in both soils. Both soils have a sodium-affected subsoil. Tilth is poor. Permeability is moderately slow in the subsoil of the Stirum soil and moderate to rapid in the underlying material. It is slow or very slow in the subsoil of the Stirum Variant soil and moderately slow to rapid in the underlying material. Available water capacity is low or moderate in both soils. During wet periods, the Stirum soil has a water table at a depth of 1 to 3 feet and is briefly ponded and the Stirum Variant soil has a water table within a depth of 1 foot and is ponded by as much as 0.5 foot of water. Runoff is very slow on both soils. The shrink-swell potential is low.

Most of the acreage supports native grasses and is used for grazing or hay. The high concentration of salts in the Stirum Variant soil limits productivity and the variety of suitable grasses. Compaction and ponding are problems. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum production.

These soils are generally unsuited to cultivated crops and to windbreaks and environmental plantings because of the wetness and the excess salts. They are suited to tame pasture and hay, but the choice of pasture plants is limited to those species that are tolerant of wetness and salts. Examples are tall wheatgrass, creeping foxtail, and reed canarygrass.

These soils are generally unsuited to building site development and septic tank absorption fields because of the ponding.

The Stirum soil is in capability unit IVw-2, Subirrigated range site, and windbreak suitability group 9; the Stirum Variant soil is in capability unit VIw-4, Saline Lowland range site, and windbreak suitability group 10.

SoA—Swenoda fine sandy loam, 0 to 2 percent slopes. This deep, moderately well drained, level and nearly level soil is on glacial lake plains. Areas are irregular in shape and range from 20 to 300 acres in size. Slopes are smooth or slightly convex.

Typically, the surface layer is dark gray fine sandy loam about 8 inches thick. The subsurface layer also is dark gray fine sandy loam about 8 inches thick. The subsoil is very friable fine sandy loam about 21 inches thick. The upper part is dark grayish brown and grayish brown, and the lower part is white and calcareous. The underlying material to a depth of 60 inches is light gray and pale yellow, calcareous silt loam. In places depth to the silty underlying material is more than 40 inches.

Included with this soil in mapping are small areas of Egeland, Hecla, Tiffany Variant, and Towner soils. These soils make up less than 15 percent of this map unit. Egeland and Hecla soils are on the slightly higher parts of the landscape. Egeland soils are dark to a depth of less than 16 inches. Hecla soils contain more sand throughout than the Swenoda soil. The somewhat poorly drained and poorly drained Tiffany Variant soils are on toe slopes. Towner soils contain more sand in the upper part than the Swenoda soil. They are in positions on the landscape similar to those of the Swenoda soil.

The content of organic matter is moderate in the Swenoda soil, and fertility is medium. Permeability is moderately rapid in the upper part of the profile and moderate or moderately slow in the underlying material. Available water capacity is moderate or high. The water table is at a depth of 2.5 to 4.0 feet during wet periods. Runoff is slow. The shrink-swell potential is low in the subsoil and moderate in the underlying material.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, and oats are the main crops. Measures that control wind erosion, conserve moisture, and maintain fertility are the main management needs. Examples are tillage practices that leave crop residue on the surface and a cropping sequence that includes grasses and legumes. Field windbreaks and stripcropping also help to control wind erosion.

If this soil is used for range, wind erosion can be a problem unless an adequate plant cover is maintained. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well. Planting after minimal site preparation helps to control wind erosion.

This soil is suited to building site development, but the wetness and the moderate shrink-swell potential in the underlying material are limitations. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

This soil is generally unsuited to septic tank absorption fields because of the wetness and the restricted permeability. The varves in the underlying material result in the slow absorption of liquid waste.

This soil is in capability unit IIIe-7, Sandy range site, and windbreak suitability group 5.

StB—Swenoda-Embden fine sandy loams, 2 to 6 percent slopes. These deep, gently sloping soils are on glacial lake plains. The moderately well drained Swenoda soil is on the upper foot slopes, and the well drained and moderately well drained Embden soil is on the lower foot slopes. Areas are irregular in shape and range from 20 to 250 acres in size. They are 45 to 55 percent Swenoda soil and 30 to 40 percent Embden soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Swenoda soil is dark gray fine sandy loam about 8 inches thick. The subsurface layer also is dark gray fine sandy loam about 8 inches thick. The subsoil is very friable fine sandy loam about 21 inches thick. The upper part is dark grayish brown and grayish brown, and the lower part is white and calcareous. The underlying material to a depth of 60 inches is light gray and pale yellow, calcareous silt loam. In places the soil is dark to a depth of less than 16 inches.

Typically, the surface layer of the Embden soil is dark gray fine sandy loam about 7 inches thick. The subsurface layer also is dark gray fine sandy loam. It is about 9 inches thick. The subsoil is very friable fine sandy loam about 27 inches thick. The upper part is grayish brown, and the lower part is light gray and calcareous. The underlying material to a depth of 60 inches is light gray, calcareous very fine sandy loam. In places the soil is dark to a depth of less than 16 inches.

Included with these soils in mapping are small areas of Hecla, Stirum, Tiffany Variant, Towner, and Wyndmere soils. These included soils make up less than 15 percent of this map unit. Hecla and Tiffany Variant soils are in positions on the landscape similar to those of the Embden soil. Hecla soils contain more sand than the Embden soil. Tiffany Variant soils are somewhat poorly drained and poorly drained. Stirum and Wyndmere soils are in the slightly lower positions on the landscape. Stirum soils have a sodium-affected subsoil. Wyndmere soils have free lime within a depth of 16 inches. Towner soils have more sand in the upper part than the Swenoda soil. They are in positions in the landscape similar to those of the Swenoda soil.

The content of organic matter is moderate in the Swenoda and Embden soils, and fertility is medium. Permeability is moderately rapid in the upper part of the Swenoda soil and moderate or moderately slow in the underlying material. It is moderately rapid in the Embden soil. Available water capacity is moderate or high in the Swenoda soil and moderate in the Embden soil. During wet periods, the Swenoda soil has a water table at a depth of 2.5 to 4.0 feet and the Embden soil has one at a depth of 4.0 to 6.0 feet. Runoff is slow on both soils. The shrink-swell potential is low in the subsoil of the Swenoda soil and moderate in the underlying material. It is low in the Embden soil.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, and oats are the main crops. Measures that control wind erosion, conserve moisture, and maintain fertility are the main management needs. Leaving crop residue on the surface and including grasses and legumes in the cropping sequence are examples. Field

windbreaks and stripcropping help to control wind erosion.

If these soils are used for range, wind erosion can be a problem unless an adequate plant cover is maintained. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, and those that require an abundant supply of moisture grow especially well. Planting after minimal site preparation helps to control wind erosion.

These soils are suited to building site development, but the moderate shrink-swell potential in the underlying material of the Swenoda soil and the wetness in both soils are limitations. In areas of the Embden soil, the sides of shallow excavations tend to cave in unless they are shored. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling and by wetness. Reinforcing the foundations and footings also helps to prevent this damage.

The Swenoda soil is generally unsuited to septic tank absorption fields because of the restricted permeability and the wetness. The varves in the underlying material result in the slow absorption of liquid waste. The Embden soil is suited to septic tank absorption fields, but the seasonal high water table is a limitation.

The Swenoda soil is in capability unit IIIe-8, Sandy range site, and windbreak suitability group 5; the Embden soil is in capability unit IIIe-8, Sandy range site, and windbreak suitability group 1.

SvA—Swenoda-Tiffany Variant fine sandy loams, 0 to 3 percent slopes. These deep, level and gently undulating soils are on glacial lake plains. The moderately well drained Swenoda soil is on foot slopes, and the somewhat poorly drained and poorly drained Tiffany Variant soil is in basins. Areas are irregular in shape and range from 20 to 200 acres in size. They are 60 to 70 percent Swenoda soil and 20 to 35 percent Tiffany Variant soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Swenoda soil is dark gray fine sandy loam about 8 inches thick. The subsurface layer also is dark gray fine sandy loam about 8 inches thick. The subsoil is very friable fine sandy loam about 21 inches thick. The upper part is dark grayish brown and grayish brown, and the lower part is white and calcareous. The underlying material to a depth of 60 inches is light gray and pale yellow, calcareous silt loam. In places the silty underlying material is below a depth of 40 inches.

Typically, the surface layer of the Tiffany Variant soil is dark gray fine sandy loam about 8 inches thick. The subsurface layer also is dark gray fine sandy loam. It is about 5 inches thick. The subsoil is about 30 inches thick. The upper part is grayish brown, very friable loamy very fine sand. The next part is light brownish gray, very friable, calcareous loamy very fine sand. The lower part is light gray, friable, calcareous silt loam. The underlying material to a depth of 60 inches is light gray, calcareous silt loam. In places the silty underlying material is below a depth of 40 inches.

Included with these soils in mapping are small areas of Stirum and Wyndmere soils. These included soils make up less than 10 percent of this map unit. Stirum soils have a sodium-affected subsoil. They are on the lower toe slopes. Wyndmere soils have free lime within a depth of 16 inches. They are on the upper toe slopes.

The content of organic matter is moderate in the Swenoda and Tiffany Variant soils, and fertility is medium. Permeability is moderately rapid in the upper part of the Swenoda soil and moderate or moderately slow in the underlying material. It is moderate in the sandy part of the Tiffany Variant soil and moderate or moderately slow in the underlying material. Available water capacity is moderate or high in the Swenoda soil and moderate in the Tiffany Variant soil. During wet periods, the Swenoda soil has a water table at a depth of 2.5 to 4.0 feet and the Tiffany Variant soil has one within a depth of 3.0 feet. As much as 1 foot of water ponds on the Tiffany Variant soil during these periods. Runoff is slow on the Swenoda soil and very slow or ponded on the Tiffany Variant soil. The shrink-swell potential is low in the subsoil of the Swenoda soil and moderate in the underlying material. It is low in the Tiffany Variant soil.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Reed canarygrass and Garrison creeping foxtail also are suitable on the Tiffany Variant soil. Wheat, corn, and oats are the main crops. Measures that control wind erosion and conserve moisture in the Swenoda soil, maintain fertility in both soils, and reduce the wetness of the Tiffany Variant soil are the main management needs. Tillage practices that leave crop residue on the surface and a cropping sequence that includes grasses and legumes help to control wind erosion, conserve moisture, and help to maintain fertility. Field windbreaks and stripcropping help to control wind erosion. In most years planting and harvesting are delayed on the Tiffany Variant soil because of the wetness and the ponding.

If these soils are used for range, wind erosion can be a problem unless an adequate plant cover is maintained. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain productivity.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, and those that require an abundant supply of moisture grow especially well on the Tiffany Variant soil. Planting after minimal site preparation helps to control wind erosion.

The Swenoda soil is suited to building site development, but the moderate shrink-swell potential in the underlying material and the wetness are limitations. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. The Tiffany Variant soil is unsuited to building site development because of the ponding.

The Swenoda soil is unsuited to septic tank absorption fields because of the wetness and the restricted permeability. The Tiffany Variant soil is unsuited to septic tank absorption fields because of the ponding and the restricted permeability. The varves in the underlying material of both soils result in the slow absorption of liquid waste.

The Swenoda soil is in capability unit IIIe-7, Sandy range site, and windbreak suitability group 5; the Tiffany Variant soil is in capability unit IIIw-5, Subirrigated range site, and windbreak suitability group 2S.

SwA—Swenoda-Turton complex, 0 to 3 percent slopes. These deep, moderately well drained, level and gently undulating soils are on glacial lake plains. The Swenoda soil is on the upper foot slopes, and the Turton soil is on the lower foot slopes. Areas are irregular in shape and range from 10 to 150 acres in size. They are 40 to 50 percent Swenoda soil and 30 to 40 percent Turton soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Swenoda soil is dark gray fine sandy loam about 8 inches thick. The subsurface layer also is dark gray fine sandy loam about 8 inches thick. The subsoil is very friable fine sandy loam about 21 inches thick. The upper part is dark grayish brown and grayish brown, and the lower part is white and calcareous. The underlying material to a depth of 60 inches is light gray and pale yellow, calcareous silt loam. In places depth to the silty underlying material is more than 40 inches.

Typically, the surface layer of the Turton soil is dark gray very fine sandy loam about 7 inches thick. The subsurface layer also is dark gray very fine sandy loam. It is about 8 inches thick. The next layer is gray very fine sandy loam about 4 inches thick. The subsoil is friable loam about 28 inches thick. The upper part is grayish brown. The lower part is grayish brown and light brownish gray, is calcareous, and has nests of salt. The underlying material to a depth of 60 inches is light gray, calcareous very fine sandy loam that has nests of salt.

Included with these soils in mapping are small areas of Camtown, Glyndon, Turton Variant, and Wyndmere soils. These included soils make up less than 20 percent of this map unit. Camtown soils do not have columnar structure in the subsoil. They are in positions on the landscape similar to those of the Turton soil. Glyndon and Wyndmere soils have free lime within a depth of 16 inches. They are on toe slopes. Turton Variant soils have visible salts within a depth of 16 inches. They are lower on the landscape than the Swenoda and Turton soils.

The content of organic matter is moderate in the Swenoda and Turton soils, and fertility is medium. The Turton soil has a sodium-affected subsoil. Tilth is poor in this soil. Permeability is moderately rapid in the upper part of the Swenoda soil and moderate or moderately slow in the underlying material. It is slow in the subsoil of the Turton soil and moderate to slow in the underlying material. Available water capacity is moderate or high in both soils. During wet periods the water table is at a depth of 2.5 to 4.0 feet in the Swenoda soil and 4.0 to 6.0 feet in the Turton soil. Runoff is slow on both soils. The shrink-swell potential is low in the subsoil of the Swenoda soil and moderate in the underlying material. It is moderate in the Turton soil.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, crested wheatgrass, and pubescent wheatgrass. Wheat, barley, corn, and oats are the main crops. The claypan subsoil and the high content of sodium in the Turton soil restrict crop growth by limiting root penetration and the rate of water intake. Measures that control wind erosion, maintain fertility, and conserve moisture in both soils and increase the rate of water intake and improve tilth in the Turton soil are the main management needs. Examples are tillage practices that leave crop residue on the surface, a cropping sequence that includes grasses and legumes, and timely tillage. Chiseling and subsoiling increase the rate of water intake and improve tilth. Field windbreaks and stripcropping are effective in controlling wind erosion.

If these soils are used for range, wind erosion can be

a problem unless an adequate plant cover is maintained. The claypan subsoil in the Turton soil limits productivity and the variety of suitable grasses. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

The Swenoda soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well. The Turton soil also is suited, but the sodium-affected subsoil is a limitation. Carefully selected trees and shrubs can be established on this soil, but optimum survival, growth, and vigor are unlikely. Planting after minimal site preparation helps to control wind erosion.

These soils are suited to building site development, but the moderate shrink-swell potential and wetness are limitations. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are generally unsuited to septic tank absorption fields because of the wetness and the restricted permeability.

The Swenoda soil is in capability unit IIIe-7, Sandy range site, and windbreak suitability group 5; the Turton soil is in capability unit IVs-2, Claypan range site, and windbreak suitability group 9.

SxA—Swenoda-Turton Variant complex, 0 to 3 percent slopes. These deep, level and gently undulating soils are on glacial lake plains. The moderately well drained Swenoda soil is on foot slopes, and the somewhat poorly drained Turton Variant soil is on toe slopes. Areas are irregular in shape and range from 10 to 150 acres in size. They are 45 to 55 percent Swenoda soil and 25 to 35 percent Turton Variant soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Swenoda soil is dark gray fine sandy loam about 8 inches thick. The subsurface layer also is dark gray fine sandy loam about 8 inches thick. The subsoil is very friable fine sandy loam about 21 inches thick. The upper part is dark grayish brown and grayish brown, and the lower part is white and calcareous. The underlying material to a depth of 60 inches is light gray and pale yellow, calcareous silt loam. In places depth to the silty underlying material is more than 40 inches.

Typically, the surface layer of the Turton Variant soil is dark gray very fine sandy loam about 8 inches thick. The subsoil is about 37 inches thick. It is friable and calcareous and has nests of salt. The upper part is dark grayish brown very fine sandy loam, the next part is grayish brown loam, and the lower part is white loam. The underlying material to a depth of 60 inches is white, calcareous very fine sandy loam.

Included with these soils in mapping are small areas of Camtown, Glyndon, Turton, and Wyndmere soils. These included soils make up less than 20 percent of this map unit. Camtown and Turton soils are in positions on the landscape between areas of the Swenoda and Turton Variant soils. Camtown soils do not have columnar structure in the subsoil. Turton soils do not have visible salt crystals within a depth of 16 inches. Glyndon and Wyndmere soils do not have a sodium-affected subsoil and have accumulations of free lime within a depth of 16 inches. They are slightly lower on the landscape than the Turton Variant soil.

The content of organic matter is moderate in the Swenoda and Turton Variant soils. Fertility is medium in the Swenoda soil and low in the Turton Variant soil. The Turton Variant soil has a sodium-affected subsoil. Tilth is poor in this soil. Permeability is moderately rapid in the upper part of the Swenoda soil and moderate or moderately slow in the underlying material. It is very slow in the subsoil of the Turton Variant soil and moderate to slow in the underlying material. Available water capacity is moderate or high in the Swenoda soil and moderate in the Turton Variant soil. During wet periods the water table is at a depth of 2.5 to 4.0 feet in the Swenoda soil and 1.0 to 3.0 feet in the Turton Variant soil. Runoff is slow on both soils. The shrink-swell potential is low in the subsoil of the Swenoda soil and moderate in the underlying material. It is moderate in the Turton Variant soil.

Most of the acreage is cropland. No crops grow well on the Turton Variant soil. The Swenoda soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, crested wheatgrass, and pubescent wheatgrass. Wheat, barley, corn, and oats are the main crops. Measures that control wind erosion, maintain fertility, and conserve moisture are the main management needs. Examples are tillage practices that leave crop residue on the surface and a cropping sequence that includes grasses and legumes. Field windbreaks and stripcropping help to control wind erosion. Other management needs are measures that increase the rate of water intake and improve tilth in the Turton Variant soil. Examples are chiseling and subsoiling.

If these soils are used for range, wind erosion can be a problem unless an adequate plant cover is maintained. Surface compaction is a problem on the Turton Variant soil. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth. The claypan subsoil in the Turton Variant soil limits productivity and the variety of suitable grasses.

Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

The Swenoda soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well. The Turton Variant soil is generally unsuited because of the sodium-affected subsoil. No trees or shrubs grow well on this soil. Planting after minimal site preparation helps to control wind erosion.

The Swenoda and Turton Variant soils are suited to building site development, but the moderate shrink-swell potential and wetness are limitations. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are generally unsuited to septic tank absorption fields because of the wetness and the restricted permeability.

The Swenoda soil is in capability unit IIIe-7, Sandy range site, and windbreak suitability group 5; the Turton Variant soil is in capability unit VIs-1, Thin Claypan range site, and windbreak suitability group 10.

TaB—Tally fine sandy loam, 2 to 6 percent slopes. This deep, well drained, gently sloping soil is on outwash plains. Areas are irregular in shape and range from 10 to 100 acres in size. Slopes are smooth and convex.

Typically, the surface layer is dark grayish brown fine sandy loam about 8 inches thick. The subsoil is very friable fine sandy loam about 35 inches thick. The upper part is dark grayish brown and brown. The lower part is grayish brown and light brownish gray and is calcareous. The upper part of the underlying material is light yellowish brown, calcareous fine sandy loam. The lower part to a depth of 60 inches is light yellowish brown, calcareous clay loam.

Included with this soil in mapping are small areas of Embden, Letcher, Niobell, Noonan, and Williams soils. These soils make up less than 15 percent of this map unit. Embden soils are dark to a depth of more than 16 inches. Letcher, Niobell, and Noonan soils have a sodium-affected subsoil. Embden, Letcher, Niobell, and Noonan soils are on the slightly lower parts of the landscape. Williams soils contain more clay in the subsoil than the Tally soil. They are in positions on the landscape similar to those of the Tally soil.

The content of organic matter is moderate in the Tally soil, and fertility is medium. Permeability is moderately rapid in the upper part of the profile and moderately slow in the underlying glacial till. Available water capacity is moderate. Runoff is slow. The shrink-swell potential is low in the upper part of the profile and moderate in the underlying glacial till.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, oats, and alfalfa are the main crops. Measures that control wind erosion, conserve moisture, and maintain fertility are the main management needs. Examples are tillage practices that leave crop residue on the surface, stripcropping, and a cropping sequence that includes grasses and legumes. A mulch of crop residue helps to control wind erosion until pasture plants are established.

If this soil is used for range, wind erosion can be a hazard unless an adequate plant cover is maintained. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well. Planting after minimal site preparation helps to control wind erosion.

This soil is suited to building site development, but the sides of shallow excavations tend to cave in unless they are shored. Septic tank absorption fields function well.

This soil is in capability unit IIIe-8, Sandy range site, and windbreak suitability group 5.

TeB—Tally-Letcher fine sandy loams, 1 to 6 percent slopes. These deep, nearly level to gently sloping soils are on outwash plains. The well drained Tally soil is on back slopes, and the moderately well drained and somewhat poorly drained Letcher soil is on foot slopes. Areas are irregular in shape and range from 15 to 150 acres in size. They are 45 to 65 percent Tally soil and 20 to 40 percent Letcher soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Tally soil is dark grayish brown fine sandy loam about 8 inches thick. The subsoil is very friable fine sandy loam about 35 inches thick. The upper part is dark grayish brown and brown. The lower part is grayish brown and light brownish gray and is calcareous. The upper part of the underlying material is light yellowish brown, calcareous fine sandy loam. The lower part to a depth of 60 inches is light yellowish brown, calcareous clay loam.

Typically, the surface layer of the Letcher soil is dark gray fine sandy loam about 8 inches thick. The subsurface layer is light brownish gray loamy fine sand about 5 inches thick. The subsoil is grayish brown, friable and very friable, calcareous sandy loam about 14 inches thick. The next layer to a depth of 34 inches is grayish brown, calcareous loam. Below this to a depth

of 45 inches is brown and light gray, calcareous loam that has nests of salt. The underlying material to a depth of 60 inches is light brownish gray, calcareous sandy loam. In some areas the underlying material is clay loam glacial till. In other areas the subsoil contains more clay.

Included with these soils in mapping are small areas of Niobell and Williams soils. These included soils make up less than 15 percent of this map unit. They contain more clay in the subsoil than the Tally and Letcher soils. Niobell soils are in positions on the landscape similar to those of the Letcher soil. Williams soils are in positions on the landscape similar to those of the Tally soil.

The content of organic matter is moderate in the Tally and Letcher soils, and fertility is medium. The Letcher soil has a sodium-affected subsoil. Permeability is moderately rapid in the upper part of the Tally soil and moderately slow in the underlying material. It is slow in the subsoil of the Letcher soil and moderate or moderately rapid in the underlying material. Available water capacity is moderate in the Tally soil and low or moderate in the Letcher soil. The Letcher soil has a seasonal high water table at a depth of 3.5 to 6.0 feet during wet periods. Runoff is slow on both soils. The shrink-swell potential is low in the upper part of the Tally soil and moderate in the underlying material. It is low in the Letcher soil.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, oats, and alfalfa are the main crops. The sodium-affected subsoil in the Letcher soil is a limitation, and wind erosion is a hazard on both soils. Measures that control erosion, conserve moisture, and maintain fertility are the main management needs. Examples are tillage systems that leave crop residue on the surface, a cropping sequence that includes grasses and legumes, and stripcropping. A mulch of crop residue helps to control wind erosion until pasture plants are established.

If these soils are used for range, wind erosion can be a hazard unless an adequate plant cover is maintained. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Tally soil. Optimum growth, survival, and vigor are unlikely on the Letcher soil because of the sodium-affected subsoil. Planting after minimal site preparation helps to control wind erosion.

The Tally soil is suited to building site development, but the sides of shallow excavations tend to cave in unless they are shored. The moderate shrink-swell potential in the underlying material also is a limitation. The Letcher soil is suited to building site development, but the wetness is a limitation. Reinforcing the foundations and footings and installing foundation drains help to prevent the structural damage caused by shrinking and swelling and by wetness.

The Tally soil is suited to septic tank absorption fields, but the restricted permeability in the underlying material is a limitation. The Letcher soil is generally unsuited to septic tank absorption fields because of the wetness.

The Tally soil is in capability unit IIIe-8, Sandy range site, and windbreak suitability group 5; the Letcher soil is in capability unit IVe-13, Sandy range site, and windbreak suitability group 9.

Tk—Tonka silt loam. This deep, poorly drained, level soil is on glacial till plains and lake plains. It is ponded during spring runoff and after heavy rains. Areas are circular or elongated and range from 5 to 75 acres in size. Slopes are concave.

Typically, the surface layer is gray silt loam about 9 inches thick. The subsurface layer is light gray silt loam about 9 inches thick. The subsoil is about 32 inches thick. It is firm. It is gray silty clay in the upper part and light brownish gray and light gray silty clay loam in the lower part. The underlying material to a depth of 60 inches is light gray silty clay loam.

Included with this soil in mapping are small areas of Bearden, Hamerly, Nishon, and Parnell soils. These soils make up less than 10 percent of this map unit. The somewhat poorly drained Bearden and Hamerly soils have free lime at the surface. They are on toe slopes. Bearden soils are on glacial lake plains, and Hamerly soils are on glacial till plains. Nishon soils are dark to a depth of less than 7 inches. They are in positions on the landscape similar to those of the Tonka soil. The very poorly drained Parnell soils are in the lower positions in basins.

The content of organic matter is high in the Tonka soil. Fertility also is high. Permeability is slow. Available water capacity is high. A seasonal high water table is within a depth of 1 foot during part of the year. As much as 0.5 foot of water ponds on the surface during some wet periods. Runoff is ponded. The shrink-swell potential is high.

About half of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are Garrison creeping foxtail and reed canarygrass. Ponding is a hazard. Crops are commonly drowned out. Wetness is the main management concern in cultivated areas. Farming is commonly delayed in most years. Installing

surface drains helps to remove the excess water, but suitable drainage outlets generally are not available.

Many areas support native grasses and are used for grazing or hay. Compaction and ponding are problems during wet periods. Restricted grazing during these periods helps to prevent compaction and deterioration of tilth. Many areas are potential sites for excavated ponds.

This soil is generally unsuited to windbreaks and environmental plantings unless it is drained. The trees and shrubs that require an abundant supply of moisture grow well in drained areas.

This soil is generally unsuited to building site development and septic tank absorption fields because of the ponding.

This soil is in capability unit IVw-1, Wet Meadow range site, and windbreak suitability group 10.

Tn—Tonka-Nishon silt loams. These deep, poorly drained, level soils are on till plains. They are ponded during periods of snowmelt or heavy rainfall. The Tonka soil generally is in the lower parts of basins and is surrounded by the Nishon soil. Slopes are smooth or slightly concave. Areas are irregularly shaped or oval and range from 5 to 30 acres in size. They are 45 to 55 percent Tonka soil and 35 to 45 percent Nishon soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Tonka soil is gray silt loam about 9 inches thick. The subsurface layer is light gray silt loam about 9 inches thick. The subsoil is about 32 inches thick. It is firm. It is gray silty clay in the upper part and light brownish gray and light gray silty clay loam in the lower part. The underlying material to a depth of 60 inches is light gray silty clay loam.

Typically, the surface layer of the Nishon soil is dark grayish brown silt loam about 4 inches thick. The subsurface layer is light gray silt loam about 4 inches thick. The subsoil is about 24 inches thick. The upper part is gray, very firm clay. The lower part is gray, firm silty clay and light brownish gray, firm, calcareous silty clay. The upper part of the underlying material is light gray, calcareous silty clay. The lower part to a depth of 60 inches is light brownish gray, calcareous clay loam.

Included with these soils in mapping are small areas of Bowbells, Hamerly, and Parnell soils. These included soils make up less than 15 percent of this map unit. The moderately well drained Bowbells soils are on foot slopes. The somewhat poorly drained Hamerly soils have free lime at the surface. They are on toe slopes between and around the basins. The very poorly drained Parnell soils are lower on the landscape than the Tonka and Nishon soils.

The content of organic matter is high in the Tonka soil and moderate in the Nishon soil. Fertility is high in the Tonka soil and medium in the Nishon soil. Tilth is fair in the Tonka soil and poor in the Nishon soil. Permeability is slow in both soils. Available water capacity is high in the Tonka soil and moderate or high in the Nishon soil. During part of the year, the seasonal high water table is within a depth of 1 foot in the Tonka soil and within a depth of 3 feet in the Nishon soil. During wet periods, as much as 0.5 foot of water can pond on the surface of the Tonka soil and 1.0 foot of water can pond on the surface of the Nishon soil. Runoff is ponded on both soils. The shrink-swell potential is high.

Many areas support native grasses and are used for grazing. Compaction and ponding are problems during wet periods. Restricted grazing during these periods helps to prevent compaction and deterioration of tilth. Many areas are potential sites for excavated ponds.

Some areas are cultivated along with the surrounding areas. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are Garrison creeping foxtail and reed canarygrass. Ponding is a hazard. Measures that improve drainage, increase the rate of water intake, and improve tilth are the main management needs. Suitable drainage outlets generally are not available. Chiseling or subsoiling and a cropping sequence that includes grasses and legumes improve tilth and increase the rate of water intake.

These soils are generally unsuited to windbreaks and environmental plantings unless they are drained. The trees and shrubs that require an abundant supply of moisture grow well in drained areas.

These soils are generally unsuited to building site development and septic tank absorption fields because of the ponding.

The Tonka soil is in capability unit IVw-1, Wet Meadow range site, and windbreak suitability group 10; the Nishon soil is in capability unit IVw-1, Closed Depression range site, and windbreak suitability group 10.

Tr—Towner-Hecla loamy fine sands. These deep, level and gently undulating soils are on sandy glacial lake plains. Slopes are 0 to 3 percent. The well drained and moderately well drained Towner soil is on back slopes, and the moderately well drained Hecla soil is on foot slopes. Areas are irregular in shape and range from 20 to several hundred acres in size. They are about 45 to 60 percent Towner soil and 30 to 45 percent Hecla soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface soil of the Towner soil is dark

gray loamy fine sand about 6 inches thick. The subsoil is about 22 inches thick. The upper part is grayish brown, very friable loamy fine sand. The lower part is light gray, friable, calcareous silt loam. The underlying material to a depth of 60 inches is pale olive, calcareous silt loam.

Typically, the surface layer of the Hecla soil is dark gray loamy fine sand about 6 inches thick. The subsurface layer is dark gray fine sand about 14 inches thick. The next layer also is dark gray fine sand. It is about 10 inches thick. The underlying material to a depth of 54 inches is grayish brown fine sand. Below this to a depth of 60 inches is very dark gray fine sandy loam.

Included with these soils in mapping are small areas of Hamar, Kratka, Maddock, and Ulen soils. These included soils make up less than 15 percent of this map unit. The somewhat poorly drained and poorly drained Hamar soils and the poorly drained and very poorly drained Kratka soils are in basins. The well drained Maddock soils are on the upper back slopes and shoulder slopes. Ulen soils have free lime at the surface. They are on toe slopes.

The content of organic matter is moderate in the Towner and Hecla soils, and fertility is medium. Permeability is rapid in the upper part of the Towner soil and moderate or moderately slow in the lower part. It is moderately rapid or rapid in the Hecla soil. Available water capacity is moderate or high in the Towner soil and low or moderate in the Hecla soil. Both soils have a water table at a depth of 3 to 6 feet during wet periods. Runoff is slow. The shrink-swell potential is low in the upper part of the Towner soil and moderate in the underlying material. It is low in the Hecla soil.

Most areas are used as cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Corn, wheat, and oats are the main crops. The hazard of wind erosion is severe. Measures that control wind erosion, maintain fertility, and conserve moisture are the main management needs. Examples are tillage practices that leave crop residue on the surface, field windbreaks, stripcropping, and a cropping sequence that includes grasses and legumes. A mulch of crop residue helps to control wind erosion until pasture plants are established.

If these soils are used for range, wind erosion can be a problem unless an adequate plant cover is maintained. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity. The risk of blowouts increases along overused livestock trails and around watering facilities.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well. The species that require an abundant supply of moisture grow especially well on the Hecla soil. Planting after minimal site preparation helps to control wind erosion.

These soils are suited to most kinds of building site development, but the sides of shallow excavations tend to cave in unless they are shored. Wetness in both soils and the moderate shrink-swell potential in the underlying material of the Towner soil are limitations. Backfilling with sandy material, installing foundation drains, and reinforcing the foundations and footings help to prevent the structural damage caused by shrinking and swelling and by wetness.

These soils are generally unsuited to septic tank absorption fields because of the wetness and a poor filtering capacity. The poor filtering capacity can result in the pollution of ground water.

The Towner soil is in capability unit IVe-9, Sands range site, and windbreak suitability group 5; the Hecla soil is in capability unit IVe-10, Sandy range site, and windbreak suitability group 1.

Tv—Turton-Turton Variant complex. These deep, level and nearly level soils are on glacial lake plains. The moderately well drained Turton soil is on foot slopes, and the somewhat poorly drained Turton Variant soil is on toe slopes. Areas are 5 to 100 acres in size and are irregular in shape. They are 55 to 65 percent Turton soil and 30 to 40 percent Turton Variant soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Turton soil is dark gray loam about 7 inches thick. The subsurface layer also is dark gray loam. It is about 8 inches thick. The next layer is gray very fine sandy loam about 4 inches thick. The subsoil is friable loam about 28 inches thick. The upper part is grayish brown. The lower part is grayish brown and light brownish gray, is calcareous, and has nests of salt. The underlying material to a depth of 60 inches is light gray, calcareous very fine sandy loam that has nests of salt.

Typically, the surface layer of the Turton Variant soil is dark gray very fine sandy loam about 8 inches thick. The subsoil is about 37 inches thick. It is friable and calcareous and has nests of salt. The upper part is dark grayish brown very fine sandy loam, the next part is grayish brown loam, and the lower part is white loam. The underlying material to a depth of 60 inches is white, calcareous very fine sandy loam.

Included with these soils in mapping are small areas of Camtown, Gardena, Stirum, Swenoda, and Wyndmere soils. These included soils make up less than 15 percent of this map unit. The moderately well

drained Camtown soils do not have columnar structure in the subsoil. They are slightly higher on the landscape than the Turton soil. The moderately well drained Gardena and Swenoda soils do not have a sodium-affected subsoil. They are in the higher positions on the landscape. The poorly drained Stirum soils are on the lower parts of the landscape. Wyndmere soils do not have a sodium-affected subsoil and have an accumulation of lime within a depth of 16 inches. They are in positions on the landscape similar to those of the Turton Variant soil.

The content of organic matter is moderate in the Turton and Turton Variant soils. Fertility is medium in the Turton soil and low in the Turton Variant soil. Both soils have a sodium-affected subsoil. Tilth is poor. Permeability is slow in the subsoil of the Turton soil and moderate to slow in the underlying material. It is very slow in the subsoil of the Turton Variant soil and moderate to slow in the underlying material. Available water capacity is moderate or high in the Turton soil and moderate in the Turton Variant soil. The seasonal high water table is at a depth of 4 to 6 feet in the Turton soil and 1 to 3 feet in the Turton Variant soil. Runoff is slow on both soils. The shrink-swell potential is moderate.

Most of the acreage is cropland. No crops grow well on the Turton Variant soil. The Turton soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, crested wheatgrass, intermediate wheatgrass, and pubescent wheatgrass. Wheat, barley, corn, and oats are the main crops. Early maturing small grain grows better than corn. The claypan subsoil and the high content of sodium restrict crop growth by limiting root penetration and the rate of water intake. Measures that conserve moisture, increase the rate of water intake, and improve tilth and fertility are the main management needs. Examples are applying manure, leaving crop residue on the surface, and including grasses and legumes in the cropping sequence. Chiseling and subsoiling increase the rate of water intake and improve tilth.

If these soils are used for range, compaction is a major problem on the Turton Variant soil. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth. The claypan subsoil in both soils limits productivity and the variety of suitable grasses. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

The Turton soil is suited to windbreaks and environmental plantings, but the Turton Variant soil is generally unsuited. The sodium-affected subsoil is the main limitation. Trees and shrubs can be established on the Turton soil, but optimum growth, survival, and vigor are unlikely. No trees or shrubs grow well on the Turton Variant soil.

These soils are suited to most building site development, but the moderate shrink-swell potential and wetness are limitations. Backfilling with sandy material, installing foundation drains, reinforcing the foundations and footings, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling.

The Turton and Turton Variant soils are generally unsuited to septic tank absorption fields because of the restricted permeability and the wetness.

The Turton soil is in capability unit IVs-2, Claypan range site, and windbreak suitability group 9; the Turton Variant soil is in capability unit VIs-1, Thin Claypan range site, and windbreak suitability group 10.

Un—Ulen fine sandy loam. This deep, moderately well drained or somewhat poorly drained, nearly level and very gently sloping soil is on glacial lake plains. Areas are irregular in shape and range from 10 to 300 acres in size. Slopes are 0 to 3 percent and are plain or slightly concave.

Typically, the surface layer is dark gray, calcareous fine sandy loam about 9 inches thick. Below this is a transitional layer of gray, calcareous fine sandy loam about 5 inches thick. The subsoil is light gray, very friable, calcareous loamy fine sand about 8 inches thick. The underlying material to a depth of 60 inches is light gray, calcareous loamy fine sand and fine sand. In places the soil contains less sand.

Included with this soil in mapping are small areas of Arveson, Fossum, Hamar, and Hecla soils. These soils make up less than 15 percent of this map unit. The poorly drained and very poorly drained Arveson and Fossum soils are on the slightly lower parts of the landscape. Hamar and Hecla soils do not have free lime near the surface. Hamar soils are in basins. Hecla soils are on the slightly higher parts of the landscape.

The content of organic matter is moderate in the Ulen soil, and fertility is medium. Permeability is rapid. Available water capacity is low. The water table is at a depth of 2.5 to 6.0 feet during wet periods. Runoff is slow. The shrink-swell potential is low.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, smooth brome, and intermediate wheatgrass. Corn, wheat, and barley are the main crops. A high content of lime in the surface layer restricts the availability of plant nutrients. Measures that control erosion and improve fertility are the main management needs. Minimizing tillage and leaving crop residue on the surface are examples.

If this soil is used for range, wind erosion can be a

problem unless an adequate plant cover is maintained. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity and an adequate plant cover. The risk of blowouts increases along overused livestock trails and around watering facilities.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, and those that require an abundant supply of moisture grow especially well.

This soil is generally unsuited to building site development and septic tank absorption fields because of the wetness and a poor filtering capacity. The poor filtering capacity can result in the pollution of ground water. The sides of shallow excavations tend to cave in unless they are shored.

This soil is in capability unit IIIe-14, Limy Subirrigated range site, and windbreak suitability group 1.

Us—Ulen-Stirum fine sandy loams. These deep, level and gently sloping soils are on glacial lake plains. Slopes are 0 to 3 percent. The somewhat poorly drained and moderately well drained Ulen soil is on the upper toe slopes, and the poorly drained Stirum soil is on the lower toe slopes. Areas are irregular in shape and range from 10 to 200 acres in size. They are 55 to 65 percent Ulen soil and 20 to 30 percent Stirum soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Ulen soil is dark gray, calcareous fine sandy loam about 9 inches thick. Below this is a transitional layer of gray, calcareous fine sandy loam about 5 inches thick. The subsoil is light gray, very friable, calcareous loamy fine sand about 8 inches thick. The underlying material to a depth of 60 inches is light gray, calcareous loamy fine sand and fine sand. In places the soil contains less sand.

Typically, the surface layer of the Stirum soil is very dark gray, calcareous fine sandy loam about 6 inches thick. The subsoil is friable, calcareous loam about 26 inches thick. The upper part is dark gray and light brownish gray, and the lower part is light gray. The underlying material to a depth of 60 inches is light gray, calcareous loamy very fine sand and loamy fine sand.

Included with these soils in mapping are small areas of the poorly drained and very poorly drained Arveson and Borup soils. These included soils make up less than 15 percent of this map unit. They are in positions on the landscape similar to those of the Stirum soil.

The content of organic matter is moderate in the Ulen and Stirum soils. Fertility is medium in the Ulen soil and low in the Stirum soil. The Stirum soil has a sodium-affected subsoil. Tilth is poor in this soil. Permeability is rapid in the Ulen soil. It is moderately slow in the subsoil of the Stirum soil and moderate to rapid in the underlying material. Available water capacity is low in both soils. During wet periods, the water table is at a depth of 2.5 to 6.0 feet in the Ulen soil and 1.0 to 3.0 feet in the Stirum soil. Water ponds on the Stirum soil for short periods. Runoff is slow on the Ulen soil and very slow on the Stirum soil. The shrink-swell potential is low in both soils.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, barley, and oats are the main crops. A high content of lime in the surface layer of both soils restricts the availability of plant nutrients and increases the susceptibility to wind erosion. The sodium-affected subsoil in the Stirum soil restricts root penetration. Measures that reduce wetness, control wind erosion, and improve fertility and tilth are the main management needs. Leaving crop residue on the surface and including grasses and legumes in the cropping sequence help to control wind erosion and improve fertility and tilth. Chiseling or subsoiling increases the rate of water intake.

If these soils are used for range, wind erosion is a problem on the Ulen soil and compaction is a problem on the Stirum soil. Grazing when the soil is wet causes surface compaction and puddling, which results in a decrease in the extent of desirable grasses. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity and an adequate plant cover. The risk of blowouts increases along overused livestock trails and around watering facilities.

The Ulen soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, and those that require an abundant supply of moisture grow especially well. The Stirum soil is suited to windbreaks and environmental plantings, but the sodium-affected subsoil and the ponding severely restrict growth. Optimum growth, survival, and vigor are unlikely.

These soils are generally unsuited to building site development and septic tank absorption fields because of the wetness and a poor filtering capacity. The poor filtering capacity can result in the pollution of ground water. The sides of shallow excavations tend to cave in unless they are shored.

The Ulen soil is in capability unit IIIe-14, Limy Subirrigated range site, and windbreak suitability group 1; the Stirum soil is in capability unit IVw-2, Subirrigated range site, and windbreak suitability group 9.

Va—Vallers clay loam. This deep, poorly drained, level and nearly level soil is on till plains. It is subject to rare flooding. Scattered stones are on the surface in some areas. Areas are long and narrow or irregularly shaped and range from 5 to 100 acres in size. Slopes are slightly concave.

Typically, the surface soil is very dark gray, calcareous clay loam about 10 inches thick. The subsoil is light gray, friable, calcareous clay loam about 13 inches thick. The underlying material to a depth of 60 inches is light olive gray and light gray, calcareous clay loam.

Included with this soil in mapping are small areas of Hamerly, Parnell, and Tonka soils. These soils make up less than 15 percent of this map unit. The somewhat poorly drained Hamerly soils are slightly higher on the landscape than the Vallers soil. The very poorly drained Parnell and poorly drained Tonka soils are in basins. In places the soil has nests of salt throughout.

The content of organic matter is high in the Vallers soil, and fertility is medium. Permeability is moderately slow. Available water capacity is high. The water table is at a depth of 1.0 to 2.5 feet during wet periods. Runoff is slow. The shrink-swell potential is moderate.

Most of the acreage supports native grasses and is used for grazing. Deferring grazing during wet periods helps to prevent compaction and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, creeping foxtail, reed canarygrass, and switchgrass. A high content of lime in the surface layer restricts the availability of plant nutrients. Measures that reduce wetness and improve fertility are the main management needs. Tillage practices that leave crop residue on the surface, a cropping sequence that includes grasses and legumes, and minimum tillage improve fertility. Because artificial drainage generally is not feasible, planting or harvesting may be delayed during wet periods.

This soil is generally unsuited to windbreaks and environmental plantings because of the wetness and the high content of lime in the surface layer.

Because of the wetness and the flooding, this soil is generally unsuited to building site development and septic tank absorption fields.

This soil is in capability unit IVw-3, Subirrigated range site, and windbreak suitability group 10.

Vs—Vallers loam, saline. This deep, poorly drained, level and nearly level soil is on low flats and in shallow basins on till plains. It is subject to rare flooding. Areas are irregular in shape and range from 10 to 130 acres in size. Slopes are slightly concave and are less than 2 percent.

Typically, the surface layer is dark gray loam about 7 inches thick. It has many nests of salt. The subsoil is light gray, calcareous clay loam about 11 inches thick. It has common or many nests of salt. The underlying material to a depth of 60 inches is pale olive and light gray, calcareous clay loam. It has many yellowish brown mottles and few or common nests of salt.

Included with this soil in mapping are small areas of Hamerly and Parnell soils. These soils make up less than 15 percent of this map unit. The somewhat poorly drained Hamerly soils are slightly higher on the landscape than the Vallers soil. The very poorly drained Parnell soils are in basins.

The content of organic matter is high in the Vallers soil, and fertility is low. Permeability is moderately slow. Available water capacity is moderate. The water table is within a depth of 1 foot during wet periods. Runoff is slow. The shrink-swell potential is low.

Most of the acreage supports native grasses and is used for grazing. The high content of salts limits productivity and the variety of suitable grasses. Deferring grazing during wet periods helps to prevent compaction and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to tame pasture and hay, but the choice of pasture plants is limited because of the salinity and the wetness. Examples of suitable pasture plants are tall wheatgrass, western wheatgrass, and switchgrass.

This soil is generally unsuited to cultivated crops, windbreaks and environmental plantings, building site development, and septic tank absorption fields because of the wetness and the excess salts.

This soil is in capability unit IVw-4, Saline Subirrigated range site, and windbreak suitability group 10.

VzC—Vida-Zahl loams, 6 to 15 percent slopes. These deep, well drained, gently rolling and rolling soils are on moraines. The Vida soil is on the lower and middle back slopes, and the Zahl soil is on the convex upper back slopes and shoulder slopes. Scattered stones are on the surface in some areas. Areas are irregular in shape and range from 10 to more than 150 acres in size. They are 50 to 60 percent Vida soil and 20 to 30 percent Zahl soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Vida soil is dark grayish brown loam about 5 inches thick. The subsoil is friable clay loam about 17 inches thick. The upper part

is grayish brown, and the lower part is light brownish gray and calcareous. The underlying material to a depth of 60 inches is light brownish gray and light yellowish brown, calcareous clay loam. In places carbonates are below a depth of 10 inches.

Typically, the surface layer of the Zahl soil is dark grayish brown, calcareous loam about 6 inches thick. The subsoil is light gray, friable, calcareous loam about 17 inches thick. The underlying material to a depth of 60 inches is pale yellow, calcareous loam.

Included with these soils in mapping are small areas of Bowbells, Tonka, and Wabek Variant soils. These included soils make up less than 20 percent of this map unit. The moderately well drained Bowbells soils are on foot slopes. The poorly drained Tonka soils are in basins. Wabek Variant soils are in positions on the landscape similar to those of the Zahl soil. They have gravelly sand within a depth of 14 inches.

The content of organic matter is moderate in the Vida and Zahl soils. Fertility is medium in the Vida soil and medium or low in the Zahl soil. Permeability is moderate in the upper part of both soils and moderately slow in the underlying material. Available water capacity is moderate or high. Runoff is medium. The shrink-swell potential is moderate.

Most of the acreage supports native grasses and is used for grazing. Water erosion is a hazard unless an adequate plant cover is maintained. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum production.

These soils are suited to cultivated crops and to tame pasture and hay. Water erosion is a severe hazard. A high content of lime in the surface layer of the Zahl soil restricts the availability of plant nutrients. Measures that control erosion and improve fertility are the main management needs. Examples are leaving crop residue on the surface and including grasses and legumes in the cropping sequence. Planting suitable pasture grasses, such as alfalfa, intermediate wheatgrass, and smooth brome, is effective in controlling erosion. Contour farming, grassed waterways, and terraces also help to control erosion, but in most areas the slopes are too short or too irregular for contouring and terracing. Grassed waterways help to keep gullies from forming.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Vida soil, except for those that require an abundant supply of moisture. The high content of lime in the Zahl soil is a limitation. Trees and shrubs can be established on this soil, but optimum survival, growth, and vigor are unlikely.

These soils are suited to building site development, but the moderate shrink-swell potential and the slope are limitations. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. The buildings should be designed so that they conform to the natural slope of the land. In some areas land shaping is needed.

These soils generally are too steep for septic tank absorption fields. Also, the restricted permeability is a limitation. The absorption fields should be installed in the less sloping areas. Enlarging the absorption area helps to overcome a slow absorption rate. Land shaping and installing the distribution lines across the slope improve the efficiency of the absorption system.

The Vida soil is in capability unit IVe-3, Silty range site, and windbreak suitability group 3; the Zahl soil is in capability unit VIe-3, Thin Upland range site, and windbreak suitability group 8.

VzE—Vida-Zahl loams, 9 to 25 percent slopes. These deep, well drained, rolling and hilly soils are on moraines. The Vida soil is on the lower and middle back slopes, and the Zahl soil is on the convex upper back slopes and shoulder slopes. In places scattered stones are on the surface. Areas are irregular in shape and range from 10 to more than 150 acres in size. They are 50 to 60 percent Vida soil and 20 to 30 percent Zahl soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Vida soil is dark grayish brown loam about 5 inches thick. The subsoil is grayish brown and light brownish gray, friable clay loam about 17 inches thick. The lower part is calcareous. The underlying material to a depth of 60 inches is light brownish gray and light yellowish brown, calcareous clay loam. In some places carbonates are below a depth of 10 inches. In other places the subsoil contains less clay.

Typically, the surface layer of the Zahl soil is dark grayish brown, calcareous loam about 6 inches thick. The subsoil is light gray, friable, calcareous loam about 17 inches thick. The underlying material to a depth of 60 inches is pale yellow, calcareous loam. In places the surface layer is less than 6 inches thick.

Included with these soils in mapping are small areas of Bowbells, Tonka, and Wabek Variant soils. These included soils make up less than 20 percent of this map unit. The moderately well drained Bowbells soils are on foot slopes. The poorly drained Tonka soils are in basins. Wabek Variant soils are in positions on the landscape similar to those of the Zahl soil. They have gravelly sand within a depth of 14 inches.

The content of organic matter is moderate in the Vida and Zahl soils. Fertility is medium in the Vida soil and low or medium in the Zahl soil. Permeability is moderate in the upper part of both soils and moderately slow in the underlying material. Available water capacity is moderate or high. Runoff is medium. The shrink-swell potential is moderate.

Most of the acreage supports native grasses and is used for grazing. Water erosion is a hazard unless an adequate plant cover is maintained. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum production.

These soils are generally unsuited to cultivated crops, tame pasture and hay, and windbreaks and environmental plantings because of the slope.

These soils are suited to most kinds of building site development, but the moderate shrink-swell potential and the slope are limitations. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. The buildings should be designed so that they conform to the natural slope of the land. In some areas land shaping is needed.

These soils generally are too steep for most sanitary facilities. Septic tank absorption fields should be installed in the less sloping areas.

The Vida soil is in capability unit VIe-3, Silty range site, and windbreak suitability group 10; the Zahl soil is in capability unit VIIe-3, Thin Upland range site, and windbreak suitability group 10.

WaB—Williams loam, 2 to 6 percent slopes. This deep, well drained, undulating soil is on till plains. Areas are irregular in shape and range from 10 to 150 acres in size. Slopes are short and convex.

Typically, the surface layer is dark grayish brown loam about 7 inches thick. The subsoil is friable clay loam about 33 inches thick. The upper part is brown and grayish brown, and the lower part is light brownish gray and light gray and is calcareous. The underlying material to a depth of 60 inches is light brownish gray, calcareous clay loam. In some areas carbonates are within a depth of 10 inches. In other areas the subsoil contains less clay.

Included with this soil in mapping are small areas of Bowbells, Niobell, Nishon, and Tonka soils. These soils make up less than 15 percent of this map unit. Bowbells soils are dark to a depth of more than 16 inches. They are on foot slopes. Niobell soils have a sodium-affected subsoil. They are slightly lower on the landscape than the Williams soil. The poorly drained Nishon and Tonka soils are in basins.

The content of organic matter is moderate in the Williams soil, and fertility is medium. Permeability is moderate in the subsoil and moderately slow in the underlying material. Available water capacity is high. Runoff is medium. The shrink-swell potential is moderate.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Measures that control erosion and conserve moisture are the main management needs. Examples are leaving crop residue on the surface, minimizing tillage, and including grasses and legumes in the cropping sequence. Contour farming and terraces can help to control erosion, but in most areas the slopes are too short or irregular for contouring and terracing. Grassed waterways help to keep gullies from forming.

No major hazards or limitations affect the use of this soil for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum production.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, except for those that require an abundant supply of moisture. Planting on the contour, where practical, conserves moisture and helps to control erosion.

This soil is suited to building site development, but the moderate shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

This soil is suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

This soil is in capability unit IIe-2, Silty range site, and windbreak suitability group 3.

WbA—Williams-Bowbells loams, 0 to 3 percent slopes. These deep, level and gently undulating soils are on till plains. The well drained Williams soil is on back slopes, and the moderately well drained Bowbells soil is on foot slopes. Areas are irregular in shape and range from 5 to more than 250 acres in size. They are 50 to 65 percent Williams soil and 20 to 30 percent Bowbells soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is friable clay loam about 33 inches thick. The

upper part is brown and grayish brown, and the lower part is light brownish gray and light gray and is calcareous. The underlying material to a depth of 60 inches is light brownish gray, calcareous clay loam. In some areas carbonates are within a depth of 10 inches. In other areas the subsoil contains less clay.

Typically, the surface layer of the Bowbells soil is dark gray loam about 7 inches thick. The subsurface layer is dark grayish brown loam about 6 inches thick. The subsoil is friable clay loam about 35 inches thick. The upper part is brown and pale brown, and the lower part is light gray and calcareous. The underlying material to a depth of 60 inches is light gray, calcareous clay loam.

Included with these soils in mapping are small areas of Niobell, Nishon, and Tonka soils. These included soils make up less than 15 percent of this map unit. Niobell soils have a sodium-affected subsoil. They are in positions on the landscape similar to those of the Bowbells soil. The poorly drained Nishon and Tonka soils are in basins.

The content of organic matter is moderate in the Williams soil and high in the Bowbells soil. Fertility is medium in the Williams soil and high in the Bowbells soil. Permeability is moderate in the subsoil of both soils and moderately slow in the underlying material. Available water capacity is high. The Bowbells soil has a water table at a depth of 4 to 6 feet during wet periods. Runoff is slow on both soils. The shrink-swell potential is moderate.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, barley, and oats are the main crops. Measures that conserve moisture are the main management needs. Examples are tillage practices that leave crop residue on the surface and minimum tillage. Because of runoff from the adjacent soils, planting and harvesting may be delayed during some wet periods on the Bowbells soil.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings. Except for the species that require an abundant supply of moisture, all climatically suited trees and shrubs grow well on the Williams soil. Those that require an abundant supply of moisture grow especially well on the Bowbells soil.

The Williams soil is suited to building site development, but the moderate shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. This soil is suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Bowbells soil is generally unsuited to building site development and septic tank absorption fields because it is subject to overland flow.

The Williams soil is in capability unit IIc-2, Silty range site, and windbreak suitability group 3; the Bowbells soil is in capability unit IIc-3, Overflow range site, and windbreak suitability group 1.

WbB—Williams-Bowbells loams, 1 to 6 percent slopes. These deep, nearly level to undulating soils are on till plains. The well drained Williams soil is on back slopes, and the moderately well drained Bowbells soil is on foot slopes. Areas are irregular in shape and range from 10 to more than 700 acres in size. They are 50 to 65 percent Williams soil and 20 to 30 percent Bowbells soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is friable clay loam about 33 inches thick. The upper part is brown and grayish brown, and the lower part is light brownish gray and light gray and is calcareous. The underlying material to a depth of 60 inches is light brownish gray, calcareous clay loam. In some areas carbonates are within a depth of 10 inches. In other areas the subsoil contains less clay.

Typically, the surface layer of the Bowbells soil is dark gray loam about 7 inches thick. The subsurface layer is dark grayish brown loam about 6 inches thick. The subsoil is friable clay loam about 35 inches thick. The upper part is brown and pale brown, and the lower part is light gray and calcareous. The underlying material to a depth of 60 inches is light gray, calcareous clay loam.

Included with these soils in mapping are small areas of Niobell, Nishon, Tonka, and Zahl soils. These included soils make up less than 15 percent of this map unit. Niobell soils have a sodium-affected subsoil. They are in positions on the landscape similar to those of the Bowbells soil. The poorly drained Nishon and Tonka soils are in basins. Zahl soils have free lime at or near the surface. They are on shoulder slopes.

The content of organic matter is moderate in the Williams soil and high in the Bowbells soil. Fertility is medium in the Williams soil and high in the Bowbells

soil. Permeability is moderate in the subsoil of both soils and moderately slow in the underlying material. Available water capacity is high. The Bowbells soil has a water table at a depth of 4 to 6 feet during wet periods. Runoff is medium on the Williams soil and slow on the Bowbells soil. The shrink-swell potential is moderate in both soils.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, oats, and barley are the main crops. The main management concerns are controlling erosion on the Williams soil and conserving moisture in both soils. Tillage practices that leave crop residue on the surface help to control erosion and conserve moisture. Contour farming and terraces can help to control erosion, but in most areas the slopes are too short and too irregular for contouring and terracing. Grassed waterways help to keep gullies from forming. Because of runoff from the adjacent soils, planting and harvesting are delayed during some wet periods on the Bowbells soil. The additional moisture is beneficial, however, in most years.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings. Except for the species that require an abundant supply of moisture, all climatically suited trees and shrubs grow well on the Williams soil. Those that require an abundant supply of moisture grow especially well on the Bowbells soil.

The Williams soil is suited to building site development, but the moderate shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. This soil is suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Bowbells soil is generally unsuited to building site development and septic tank absorption fields because it is subject to overland flow.

The Williams soil is in capability unit IIe-2, Silty range site, and windbreak suitability group 3; the Bowbells soil is in capability unit IIc-3, Overflow range site, and windbreak suitability group 1.

WdA—Williams-Bowbells-Tonka complex, 0 to 3 percent slopes. These deep, level to gently undulating soils are on till plains. The well drained Williams soil is on back slopes. The moderately well drained Bowbells soil is on foot slopes. The poorly drained Tonka soil is in basins. It is ponded during spring runoff and after heavy rains. In some convex areas scattered stones are on the surface. Areas are irregular in shape and range from 60 to 250 acres in size. They are 45 to 55 percent Williams soil, 20 to 25 percent Bowbells soil, and 10 to 15 percent Tonka soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is friable clay loam about 33 inches thick. The upper part is brown and grayish brown, and the lower part is light brownish gray and light gray and is calcareous. The underlying material to a depth of 60 inches is light brownish gray, calcareous clay loam. In some areas carbonates are within a depth of 10 inches. In other areas the subsoil contains less clay.

Typically, the surface layer of the Bowbells soil is dark gray loam about 7 inches thick. The subsurface layer is dark grayish brown loam about 6 inches thick. The subsoil is friable clay loam about 35 inches thick. The upper part is brown and pale brown, and the lower part is light gray and calcareous. The underlying material to a depth of 60 inches is light gray, calcareous clay loam.

Typically, the surface layer of the Tonka soil is gray silt loam about 9 inches thick. The subsurface layer is light gray silt loam about 9 inches thick. The subsoil is about 32 inches thick. It is firm. It is gray silty clay in the upper part and light brownish gray and light gray silty clay loam in the lower part. The underlying material to a depth of 60 inches is light gray silty clay loam.

Included with these soils in mapping are small areas of Cresbard, Niobell, Nishon, and Noonan soils. These included soils make up less than 15 percent of this map unit. Cresbard, Niobell, and Noonan soils have a sodium-affected subsoil. Cresbard and Noonan soils are slightly lower on the landscape than the Bowbells soil. Niobell soils are in positions on the landscape similar to those of the Bowbells soil. Nishon soils have a surface layer that is 1 to 4 inches thick. They are in positions on the landscape similar to those of the Tonka soil.

The content of organic matter is moderate in the Williams soil and high in the Bowbells and Tonka soils. Fertility is medium in the Williams soil and high in the Bowbells and Tonka soils. Permeability is moderate in the subsoil of the Williams and Bowbells soils and moderately slow in the underlying material. It is slow in

the Tonka soil. Available water capacity is high in all three soils. During wet periods the water table is at a depth of 4 to 6 feet in the Bowbells soil and is within a depth of 1 foot in the Tonka soil. As much as 0.5 foot of water ponds on the Tonka soil during some wet periods. Runoff is slow on the Williams and Bowbells soils and ponded on the Tonka soil. The shrink-swell potential is moderate in the Williams and Bowbells soils and high in the Tonka soil.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Garrison creeping foxtail and reed canarygrass also are suitable on the Tonka soil. Wheat, corn, barley, and oats are the main crops. Because of runoff from the Williams soil, planting and harvesting are delayed in some areas of the Bowbells and Tonka soils. Measures that conserve moisture in the Williams and Bowbells soils and that control ponding on the Tonka soil are the main management needs. Leaving crop residue on the surface and minimizing tillage conserve moisture. In most years planting is delayed on the Tonka soil because of the ponding. Surface drains help to remove the excess water.

No major hazards or limitations affect the use of the Williams and Bowbells soils for range. Surface compaction is a problem on the Tonka soil during wet periods. Restricted grazing during these periods helps to prevent compaction. Many areas of the Tonka soil are potential sites for excavated ponds.

The Williams and Bowbells soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Williams soil, except for those that require an abundant supply of moisture. The Bowbells soil is especially well suited to the species that require an abundant supply of moisture. The Tonka soil is generally unsuited to windbreaks and environmental plantings unless it is drained.

The Williams soil is suited to building site development, but the moderate shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. This soil is suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Bowbells and Tonka soils are generally unsuited to building site development and sanitary facilities. The Bowbells soil is subject to overland flow, and the Tonka soil is subject to ponding.

The Williams soil is in capability unit IIc-2, Silty range site, and windbreak suitability group 3; the Bowbells soil is in capability unit IIc-3, Overflow range site, and windbreak suitability group 1; the Tonka soil is in capability unit IVw-1, Wet Meadow range site, and windbreak suitability group 10.

WdB—Williams-Bowbells-Tonka complex, 0 to 6 percent slopes. These deep, level to undulating soils are on till plains. The well drained Williams soil is on back slopes. Scattered stones are on the surface in some areas. The moderately well drained Bowbells soil is on foot slopes. The poorly drained Tonka soil is in basins. It is ponded during spring runoff and after heavy rains. Areas are irregular in shape and range from 60 to more than 500 acres in size. They are 45 to 55 percent Williams soil, 20 to 25 percent Bowbells soil, and 10 to 15 percent Tonka soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is friable clay loam about 33 inches thick. The upper part is brown and grayish brown, and the lower part is light brownish gray and light gray and is calcareous. The underlying material to a depth of 60 inches is light brownish gray, calcareous clay loam. In some areas carbonates are within a depth of 10 inches. In other areas the subsoil contains less clay.

Typically, the surface layer of the Bowbells soil is dark gray loam about 7 inches thick. The subsurface layer is dark grayish brown loam about 6 inches thick. The subsoil is friable clay loam about 35 inches thick. The upper part is grayish brown and brown, and the lower part is light gray and calcareous. The underlying material to a depth of 60 inches is light gray, calcareous clay loam.

Typically, the surface layer of the Tonka soil is gray silt loam about 9 inches thick. The subsurface layer is light gray silt loam about 9 inches thick. The subsoil is about 32 inches thick. It is firm. It is gray silty clay in the upper part and light brownish gray and light gray silty clay loam in the lower part. The underlying material to a depth of 60 inches is light gray silty clay loam.

Included with these soils in mapping are small areas of Cresbard, Niobell, Nishon, Noonan, and Renshaw soils. These included soils make up less than 15 percent of this map unit. Cresbard, Niobell, and Noonan soils have a sodium-affected subsoil. Cresbard and Noonan soils are slightly lower on the landscape than the Bowbells soil. Niobell soils are in positions on the

landscape similar to those of the Bowbells soil. Renshaw soils are 14 to 20 inches deep over gravelly sand. They are on shoulder slopes. Nishon soils have a surface layer that is 1 to 4 inches thick. They are in positions on the landscape similar to those of the Tonka soil.

The content of organic matter is moderate in the Williams soil and high in the Bowbells and Tonka soils. Fertility is medium in the Williams soil and high in the Bowbells and Tonka soils. Permeability is moderate in the subsoil of the Williams and Bowbells soils and moderately slow in the underlying material. It is slow in the Tonka soil. Available water capacity is high in all three soils. During wet periods the water table is at a depth of 4 to 6 feet in the Bowbells soil and is within a depth of 1 foot in the Tonka soil. As much as 0.5 foot of water ponds on the Tonka soil during some wet periods. Runoff is medium on the Williams soil, slow on the Bowbells soil, and ponded on the Tonka soil. The shrink-swell potential is moderate in the Williams and Bowbells soils and high in the Tonka soil.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Garrison creeping foxtail and reed canarygrass also are suitable on the Tonka soil. Wheat, corn, barley, and oats are the main crops. Because of runoff from the Williams soil, planting and harvesting are delayed in some areas of the Bowbells and Tonka soils. Measures that control erosion and conserve moisture in areas of the Williams soil, that conserve moisture in the Bowbells soil, and that control ponding on the Tonka soil are the main management needs. Leaving crop residue on the surface and minimizing tillage conserve moisture. Contour farming, grassed waterways, and terraces can help to control erosion, but in most areas the slopes are too short or too irregular for contouring and terracing. In most years planting is delayed on the Tonka soil because of the ponding. Surface drains help to remove the excess water.

No major hazards or limitations affect the use of the Williams and Bowbells soils for range. Surface compaction is a problem on the Tonka soil during wet periods. Restricted grazing during these periods helps to prevent compaction. Many areas of the Tonka soil are potential sites for excavated ponds.

The Williams and Bowbells soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Williams soil, except for those that require an abundant supply of moisture. The Bowbells soil is especially well suited to the species that require an abundant supply of moisture. The Tonka soil is generally unsuited to windbreaks and environmental plantings unless it is drained.

The Williams soil is suited to building site development, but the moderate shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. This soil is suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Bowbells and Tonka soils are generally unsuitable as sites for buildings and sanitary facilities. The Bowbells soil is subject to overland flow, and the Tonka soil is subject to ponding.

The Williams soil is in capability unit IIe-2, Silty range site, and windbreak suitability group 3; the Bowbells soil is in capability unit IIc-3, Overflow range site, and windbreak suitability group 1; the Tonka soil is in capability unit IVw-1, Wet Meadow range site, and windbreak suitability group 10.

WfA—Williams-Cavour loams, 0 to 3 percent slopes. These deep, level and gently undulating soils are on uplands. The well drained Williams soil is on back slopes, and the moderately well drained Cavour soil is on foot slopes. Areas are irregular in shape and range from 10 to 150 acres in size. They are 50 to 60 percent Williams soil and 20 to 30 percent Cavour soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is friable clay loam about 33 inches thick. The upper part is brown and grayish brown, and the lower part is light brownish gray and light gray and is calcareous. The underlying material to a depth of 60 inches is light brownish gray, calcareous clay loam. In some areas carbonates are within a depth of 10 inches. In other areas the subsoil contains less clay.

Typically, the surface layer of the Cavour soil is dark gray loam about 8 inches thick. The subsurface layer is gray loam about 2 inches thick. The subsoil is about 17 inches thick. It is firm. The upper part is dark grayish brown clay. The lower part is grayish brown, calcareous clay loam that has nests of salt. The underlying material to a depth of 60 inches is light brownish gray and light gray, calcareous clay loam.

Included with these soils in mapping are small areas of Bowbells, Cresbard, Hamerly, and Tonka soils. These included soils make up less than 20 percent of this map unit. Bowbells and Cresbard soils are on the

lower side slopes and in swales. Bowbells soils do not have a sodium-affected subsoil and are dark to a depth of more than 16 inches. Cresbard soils do not have columnar structure in the subsoil. Hamerly soils have free lime at the surface. They are on the outer edges of basins. The poorly drained Tonka soils are in the basins.

The content of organic matter is moderate in the Williams and Cavour soils, and fertility is medium. The Cavour soil has a sodium-affected subsoil. Tilth is good in the Williams soil and poor in the Cavour soil. Permeability is moderate in the subsoil of the Williams soil and moderately slow in the underlying material. It is very slow or slow in the subsoil of the Cavour soil and moderately slow or slow in the underlying material. Available water capacity is high in the Williams soil and moderate in the Cavour soil. Runoff is slow on both soils. The shrink-swell potential is moderate in the Williams soil. It is high in the subsoil of the Cavour soil and moderate in the underlying material.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, barley, corn, and oats are the main crops. The sodium-affected subsoil in the Cavour soil restricts crop growth by limiting root penetration and the rate of water intake. Measures that conserve moisture in the Williams soil and that increase the rate of water intake and improve tilth in the Cavour soil are the main management needs. Examples are leaving crop residue on the surface, minimizing tillage, and including grasses and legumes in the cropping sequence. Chiseling and subsoiling increase the rate of water intake and improve tilth.

If these soils are used for range, the dense, sodium-affected subsoil in the Cavour soil limits productivity and the variety of suitable grasses. Surface compaction is a problem on the Cavour soil during wet periods. Restricted grazing during these periods helps to prevent compaction and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings, but the dense claypan subsoil in the Cavour soil is a limitation. Except for the species that require an abundant supply of moisture, all climatically suited trees and shrubs grow well on the Williams soil. The sodium-affected subsoil in the Cavour soil severely limits root penetration. Optimum survival, growth, and vigor of trees and shrubs are unlikely on this soil.

These soils are suited to building site development, but the moderate shrink-swell potential in the Williams soil and the high shrink-swell potential in the Cavour soil are limitations. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Williams soil is in capability unit IIc-2, Silty range site, and windbreak suitability group 3; the Cavour soil is in capability unit IVs-2, Claypan range site, and windbreak suitability group 9.

WfB—Williams-Cavour loams, 3 to 6 percent slopes. These deep, undulating soils are on till plains. The well drained Williams soil is on back slopes, and the moderately well drained Cavour soil is on foot slopes. Areas are irregular in shape and range from 10 to 150 acres in size. They are 50 to 60 percent Williams soil and 20 to 30 percent Cavour soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is friable clay loam about 33 inches thick. The upper part is brown and grayish brown, and the lower part is light brownish gray and light gray and is calcareous. The underlying material to a depth of 60 inches is light brownish gray, calcareous clay loam. In some areas carbonates are within a depth of 10 inches. In other areas the subsoil contains less clay.

Typically, the surface layer of the Cavour soil is dark gray loam about 8 inches thick. The subsurface layer is gray loam about 2 inches thick. The subsoil is about 17 inches thick. It is firm. The upper part is dark grayish brown clay. The lower part is grayish brown, calcareous clay loam that has nests of salt. The underlying material to a depth of 60 inches is light brownish gray and light gray, calcareous clay loam.

Included with these soils in mapping are small areas of Bowbells, Cresbard, Hamerly, Tonka, and Zahl soils. These included soils make up less than 20 percent of this map unit. Bowbells and Cresbard soils are on the lower slopes. Bowbells soils do not have a sodium-affected subsoil and are dark to a depth of more than 16 inches. Cresbard soils do not have columnar structure in the subsoil. Hamerly soils have free lime at the surface. They are on toe slopes between and around basins. The poorly drained Tonka soils are in the basins. Zahl soils have free lime at or near the surface. They are on shoulder slopes.

The content of organic matter is moderate in the

Williams and Cavour soils, and fertility is medium. The Cavour soil has a sodium-affected subsoil. Tilth is good in the Williams soil and poor in the Cavour soil. Permeability is moderate in the subsoil of the Williams soil and moderately slow in the underlying material. It is very slow or slow in the subsoil of the Cavour soil and moderately slow or slow in the underlying material. Available water capacity is high in the Williams soil and moderate in the Cavour soil. Runoff is medium on the Williams soil and slow on the Cavour soil. The shrink-swell potential is moderate in the Williams soil. It is high in the subsoil of the Cavour soil and moderate in the underlying material.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, barley, corn, and oats are the main crops. The sodium-affected subsoil in the Cavour soil restricts crop growth by limiting root penetration and the rate of water intake. Controlling erosion and conserving moisture in areas of the Williams soil and improving the tilth and the rate of water intake in the Cavour soil are the main management concerns. Leaving crop residue on the surface and minimizing tillage help to control erosion and conserve moisture. Contour farming, grassed waterways, and terraces can help to control erosion, but in most areas the slopes are too short or too irregular for contouring and terracing. A cropping sequence that includes grasses and legumes, timely tillage, and chiseling or subsoiling increase the rate of water intake and improve tilth.

If these soils are used for range, the dense, sodium-affected subsoil in the Cavour soil limits productivity and the variety of suitable grasses. Surface compaction is a problem on the Cavour soil during wet periods. Restricted grazing during these periods helps to prevent compaction and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings, but the dense claypan subsoil in the Cavour soil is a limitation. Except for the species that require an abundant supply of moisture, all climatically suited trees and shrubs grow well on the Williams soil. The sodium-affected subsoil in the Cavour soil severely limits root penetration. Optimum survival, growth, and vigor of trees and shrubs are unlikely on this soil.

These soils are suited to building site development, but the moderate shrink-swell potential in the Williams soil and the high shrink-swell potential in the Cavour soil are limitations. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Williams soil is in capability unit IIe-2, Silty range site, and windbreak suitability group 3; the Cavour soil is in capability unit IVs-3, Claypan range site, and windbreak suitability group 9.

WhA—Williams-Cresbard-Tonka complex, 0 to 3 percent slopes. These deep, level to gently undulating soils are on till plains. The well drained Williams soil is on back slopes. The moderately well drained Cresbard soil is on foot slopes. The poorly drained Tonka soil is in basins. It is ponded during spring runoff and after heavy rains. Areas are irregular in shape and range from 20 to more than 1,000 acres in size. They are 45 to 55 percent Williams soil, 20 to 25 percent Cresbard soil, and 10 to 15 percent Tonka soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is friable clay loam about 33 inches thick. The upper part is brown and grayish brown, and the lower part is light brownish gray and light gray and is calcareous. The underlying material to a depth of 60 inches is light brownish gray, calcareous clay loam. In some areas carbonates are within a depth of 10 inches. In other areas the subsoil contains less clay.

Typically, the surface layer of the Cresbard soil is dark gray loam about 7 inches thick. The subsurface layer is grayish brown loam about 3 inches thick. Below this is a transitional layer about 6 inches thick. This layer is grayish brown clay loam that has gray silt coatings on faces of peds. The subsoil is firm clay loam about 29 inches thick. The upper part is grayish brown and light brownish gray, and the lower part is light yellowish brown and calcareous. The underlying material to a depth of 60 inches is light yellowish brown, calcareous clay loam. In some areas the subsoil contains less clay.

Typically, the surface layer of the Tonka soil is gray silt loam about 9 inches thick. The subsurface layer is light gray silt loam about 9 inches thick. The subsoil is about 32 inches thick. It is firm. It is gray silty clay in the upper part and light brownish gray and light gray silty clay loam in the lower part. The underlying material to a depth of 60 inches is light gray silty clay loam.

Included with these soils in mapping are small areas

of Bowbells, Cavour, Hamerly, and Nishon soils. These included soils make up less than 15 percent of this map unit. Bowbells soils have a surface layer that is thicker than that of the Williams soil. They are in positions on the landscape similar to those of the Cresbard soil. Cavour soils have columnar structure in the subsoil. They are in the slightly lower microlows. Hamerly soils have free lime at the surface. They are on toe slopes between and around basins. Nishon soils have a surface layer that is thinner than that of the Tonka soil. They are in positions on the landscape similar to those of the Tonka soil.

The content of organic matter is moderate in the Williams and Cresbard soils and high in the Tonka soil. Fertility is medium in the Williams and Cresbard soils and high in the Tonka soil. The Cresbard soil has a sodium-affected subsoil. Tilth is good in the Williams soil and fair in the Cresbard and Tonka soils. Permeability is moderate in the subsoil of the Williams soil and moderately slow in the underlying material. It is moderately slow or slow in the Cresbard soil and slow in the Tonka soil. Available water capacity is high in the Williams and Tonka soils and moderate in the Cresbard soil. During wet periods the water table is within a depth of 1 foot in the Tonka soil. As much as 0.5 foot of water may pond on this soil. Runoff is slow on the Williams and Cresbard soils and ponded on the Tonka soil. The shrink-swell potential is moderate in the Williams soil and high in the Tonka soil. It is high in the subsoil of the Cresbard soil and moderate in the underlying material.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Water-tolerant species, such as Garrison creeping foxtail and reed canarygrass, also are suitable on the Tonka soil. Wheat, corn, barley, and oats are the main crops. The sodium-affected subsoil in the Cresbard soil restricts root penetration. Measures that conserve moisture in the Williams and Cresbard soils and that control ponding on the Tonka soil are the main management needs. Minimum tillage, tillage practices that leave crop residue on the surface, a cropping sequence that includes grasses and legumes, and timely tillage are examples. In most years planting is delayed on the Tonka soil because of the ponding. Suitable drainage outlets generally are not available.

No major hazards or limitations affect the use of the Williams and Cresbard soils for range. Surface compaction is a problem on the Tonka soil during wet periods. Restricted grazing during these periods helps to prevent compaction. Many areas of the Tonka soil are potential sites for excavated ponds.

The Williams and Cresbard soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Williams soil, except for those that require an abundant supply of moisture. The Cresbard soil takes in water slowly and has a clayey subsoil that restricts the penetration of plant roots. Windbreaks can be established on this soil, but optimum growth is unlikely. The Tonka soil is generally unsuited to windbreaks and environmental plantings unless it is drained.

The Williams and Cresbard soils are suited to building site development, but the moderate shrink-swell potential in the Williams soil and the high shrink-swell potential in the subsoil of the Cresbard soil are limitations. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

The Williams and Cresbard soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Tonka soil is generally unsuitable as a site for buildings and sanitary facilities because of the ponding.

The Williams soil is in capability unit IIc-2, Silty range site, and windbreak suitability group 3; the Cresbard soil is in capability unit IIIs-1, Clayey range site, and windbreak suitability group 4L; the Tonka soil is in capability unit IVw-1, Wet Meadow range site, and windbreak suitability group 10.

WhB—Williams-Cresbard-Tonka complex, 0 to 6 percent slopes. These deep, level to undulating soils are on till plains. The well drained Williams soil is on back slopes. The moderately well drained Cresbard soil is on foot slopes. The poorly drained Tonka soil is in basins. It is ponded during spring runoff and after heavy rains. Areas are irregular in shape and range from 20 to more than 1,000 acres in size. They are 45 to 55 percent Williams soil, 20 to 25 percent Cresbard soil, and 10 to 15 percent Tonka soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is friable clay loam about 33 inches thick. The upper part is brown and grayish brown, and the lower part is light brownish gray and light gray and is calcareous. The underlying material to a depth of 60 inches is light brownish gray, calcareous clay loam. In some areas carbonates are within a depth of 10 inches. In other areas the subsoil contains less clay.

Typically, the surface layer of the Cresbard soil is dark gray loam about 7 inches thick. The subsurface

layer is grayish brown loam about 3 inches thick. Below this is a transitional layer about 6 inches thick. This layer is grayish brown clay loam that has gray silt coatings on faces of peds. The subsoil is firm clay loam about 29 inches thick. It is grayish brown and light brownish gray in the upper part and light yellowish brown and calcareous in the lower part. The underlying material to a depth of 60 inches is light yellowish brown, calcareous clay loam. In places the subsoil contains less clay.

Typically, the surface layer of the Tonka soil is gray silt loam about 9 inches thick. The subsurface layer is light gray silt loam about 9 inches thick. The subsoil is about 32 inches thick. It is firm. It is gray silty clay in the upper part and light brownish gray and light gray silty clay loam in the lower part. The underlying material to a depth of 60 inches is light gray silty clay loam.

Included with these soils in mapping are small areas of Bowbells, Cavour, Hamerly, Nishon, and Zahl soils. These included soils make up less than 15 percent of this map unit. Bowbells soils have a surface layer that is thicker than that of the Williams soil. They are in positions on the landscape similar to those of the Cresbard soil. Cavour soils have columnar structure in the subsoil. They are in the slightly lower microlows. Hamerly soils have free lime at the surface. They are on toe slopes between and around the edges of basins. Nishon soils have a surface layer that is thinner than that of the Tonka soil. They are in positions on the landscape similar to those of the Tonka soil. Zahl soils have lime at or near the surface. They are on shoulder slopes.

The content of organic matter is moderate in the Williams and Cresbard soils and high in the Tonka soil. Fertility is medium in the Williams and Cresbard soils and high in the Tonka soil. The Cresbard soil has a sodium-affected subsoil. Tilth is good in the Williams soil and fair in the Cresbard and Tonka soils. Permeability is moderate in the subsoil of the Williams soil and moderately slow in the underlying material. It is moderately slow or slow in the Cresbard soil and slow in the Tonka soil. Available water capacity is high in the Williams and Tonka soils and moderate in the Cresbard soil. The Tonka soil has a water table within a depth of 1 foot during wet periods. As much as 0.5 foot of water ponds on this soil during these periods. Runoff is medium on the Williams soil, slow on the Cresbard soil, and ponded on the Tonka soil. The shrink-swell potential is moderate in the Williams soil and high in the Tonka soil. It is high in the subsoil of the Cresbard soil and moderate in the underlying material.

Most areas are used as cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Water-tolerant species, such as Garrison creeping foxtail and reed canarygrass, also are suitable on the Tonka soil. Wheat, barley, corn, and oats are the main crops. The sodium-affected subsoil in the Cresbard soil restricts root penetration. Measures that control erosion and conserve moisture in areas of the Williams and Cresbard soils and that control ponding on the Tonka soil are the main management needs. Tillage practices that leave crop residue on the surface, a cropping sequence that includes grasses and legumes, and timely tillage are examples. In most years planting is delayed on the Tonka soil because of the ponding. Suitable drainage outlets generally are not available. In most areas the slopes are too short and too irregular for contouring and terracing. Grassed waterways help to keep gullies from forming.

No major hazards or limitations affect the use of the Williams and Cresbard soils for range. Surface compaction is a problem on the Tonka soil during wet periods. Restricted grazing during these periods helps to prevent compaction. Areas of the Tonka soil are potential sites for excavated ponds.

The Williams and Cresbard soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Williams soil, except for those that require an abundant supply of moisture. The Cresbard soil takes in water slowly and has a clayey subsoil that restricts the penetration of plant roots. Windbreaks can be established on this soil, but optimum growth is unlikely. The Tonka soil is generally unsuited to windbreaks and environmental plantings unless it is drained.

The Williams and Cresbard soils are suited to building site development, but the moderate shrink-swell potential in the Williams soil and the high shrink-swell potential in the subsoil of the Cresbard soil are limitations. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

The Williams and Cresbard soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Tonka soil is generally unsuitable as a site for buildings and sanitary facilities because of the ponding.

The Williams soil is in capability unit IIe-2, Silty range site, and windbreak suitability group 3; the Cresbard soil is in capability unit IIIe-15, Clayey range site, and windbreak suitability group 4L; the Tonka soil is in capability unit IVw-1, Wet Meadow range site, and windbreak suitability group 10.

WnB—Williams-Niobell loams, 1 to 6 percent slopes. These deep, nearly level to undulating soils are on till plains. The well drained Williams soil is on back slopes, and the moderately well drained Niobell soil is on foot slopes. Areas are irregular in shape and range from 20 to more than 300 acres in size. They are 50 to 60 percent Williams soil and 20 to 35 percent Niobell soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is friable clay loam about 33 inches thick. The upper part is brown and grayish brown, and the lower part is light brownish gray and light gray and is calcareous. The underlying material to a depth of 60 inches is light brownish gray, calcareous clay loam. In some areas the soil has carbonates within a depth of 10 inches. In other areas the subsoil contains less clay.

Typically, the surface layer of the Niobell soil is dark grayish brown loam about 8 inches thick. The subsurface layer is grayish brown loam about 2 inches thick. The next layer is dark grayish brown clay loam about 6 inches thick. The subsoil is friable clay loam about 30 inches thick. It is grayish brown in the upper part, yellowish brown in the next part, and light yellowish brown and calcareous in the lower part. The underlying material to a depth of 60 inches is pale yellow, calcareous clay loam. In places the subsoil contains more clay.

Included with these soils in mapping are small areas of Bowbells, Miranda, Noonan, and Tonka soils. These included soils make up less than 15 percent of this map unit. Bowbells soils are dark to a depth of more than 16 inches. They are in positions on the landscape similar to those of the Niobell soil. Miranda soils have visible salts within a depth of 16 inches. They are in the slightly lower microlows. Noonan soils have columnar structure in the subsoil. They are slightly lower on the landscape than the Niobell soil. The poorly drained Tonka soils are in basins.

The content of organic matter is moderate in the Williams and Niobell soils, and fertility is medium. The Niobell soil has a sodium-affected subsoil. Permeability is moderate in the subsoil of the Williams soil and moderately slow in the underlying material. It is slow in the Niobell soil. Available water capacity is high in the Williams soil and moderate or high in the Niobell soil. Runoff is medium on both soils. The shrink-swell potential is moderate in the Williams soil. It is high in the subsoil of the Niobell soil and moderate in the underlying material.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, oats, and barley are the main crops. The sodium-affected subsoil in the Niobell soil restricts crop growth by limiting root penetration and the rate of water intake. Measures that control erosion and conserve moisture and that increase the rate of water intake in the Niobell soil are the main management needs. Examples are tillage practices that leave crop residue on the surface, a cropping sequence that includes grasses and legumes, and timely tillage. Chiseling or subsoiling increases the rate of water intake.

No hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum production.

The Williams soil is suited to windbreaks and environmental plantings. Except for the species that require an abundant supply of moisture, all climatically suited trees and shrubs grow well. The Niobell soil is suited to windbreaks and environmental plantings, but the sodium-affected subsoil limits the penetration of roots. Windbreaks can be established on this soil, but optimum growth is unlikely.

These soils are suited to most kinds of building site development, but the moderate or high shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage.

These soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate.

The Williams soil is in capability unit IIe-2, Silty range site, and windbreak suitability group 3; the Niobell soil is in capability unit IIIs-1, Clayey range site, and windbreak suitability group 4L.

WrD—Williams-Vida loams, 6 to 15 percent slopes. These deep, well drained, gently rolling and rolling soils are on moraines. The Williams soil is on the middle and lower back slopes, and the Vida soil is on the convex upper back slopes and summits. In places scattered stones cover 3 to 10 percent of the surface. Areas are irregular in shape and range from 10 to more than 400 acres in size. They are 45 to 55 percent Williams soil and 30 to 40 percent Vida soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The

subsoil is friable clay loam about 33 inches thick. The upper part is brown and grayish brown, and the lower part is light brownish gray and light gray and is calcareous. The underlying material to a depth of 60 inches is light brownish gray, calcareous clay loam. In places the subsoil contains less clay.

Typically, the surface layer of the Vida soil is dark grayish brown loam about 5 inches thick. The subsoil is friable clay loam about 17 inches thick. The upper part is grayish brown, and the lower part is light brownish gray and is calcareous. The underlying material to a depth of 60 inches is light brownish gray and light yellowish brown, calcareous clay loam.

Included with these soils in mapping are small areas of Bowbells, Tonka, Wabek Variant, and Zahl soils. These included soils make up less than 15 percent of this map unit. The moderately well drained Bowbells soils are on foot slopes. The poorly drained Tonka soils are in basins. Wabek Variant and Zahl soils are in positions on the landscape similar to those of the Vida soil. Wabek Variant soils are shallow over gravelly sand. Zahl soils have free lime near the surface.

The content of organic matter is moderate in the Williams and Vida soils, and fertility is medium. Permeability is moderate in the subsoil and moderately slow in the underlying material. Available water capacity is high in the Williams soil and moderate or high in the Vida soil. Runoff is medium on both soils. The shrink-swell potential is moderate.

Most of the acreage supports native grasses and is used for grazing. Water erosion can be a problem unless an adequate plant cover is maintained. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum production.

These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Measures that control erosion and conserve moisture are the main management needs. Examples are leaving crop residue on the surface and including grasses and legumes in the cropping sequence. Contour farming and terraces can help to control erosion, but in most areas the slopes are too short and too irregular for contouring and terracing. Grassed waterways help to keep gullies from forming.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, except for those species that require an abundant supply of moisture. Planting on the contour helps to control erosion and conserves moisture.

These soils are suited to building site development, but the moderate shrink-swell potential and the slope are limitations. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. The buildings should be designed so that they conform to the natural slope of the land. In some areas land shaping is needed.

These soils are suited to septic tank absorption fields, but the restricted permeability and the slope are limitations. The absorption fields should be installed in the less sloping areas. Land shaping and installing the distribution lines across the slope improve the efficiency of the absorption system. Enlarging the absorption area helps to overcome a slow absorption rate.

The Williams soil is in capability unit IIIe-2, Silty range site, and windbreak suitability group 3; the Vida soil is in capability unit IVe-3, Silty range site, and windbreak suitability group 3.

WsC—Williams-Zahl-Bowbells loams, 1 to 9 percent slopes. These deep, nearly level to gently rolling soils are on moraines dissected by many small drainageways. The well drained Williams soil is on convex back slopes, the well drained Zahl soil is on shoulder slopes, and the moderately well drained Bowbells soil is on foot slopes. Most areas are irregular in shape and range from 10 to 100 acres in size. They are 40 to 50 percent Williams soil, 20 to 25 percent Zahl soil, and 15 to 20 percent Bowbells soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is friable clay loam about 33 inches thick. The upper part is brown and grayish brown, and the lower part is light brownish gray and light gray and is calcareous. The underlying material to a depth of 60 inches is light brownish gray, calcareous clay loam. In some places carbonates are within a depth of 10 inches. In other places the subsoil contains less clay.

Typically, the surface layer of the Zahl soil is dark grayish brown, calcareous loam about 7 inches thick. The subsoil is light gray, friable, calcareous loam about 17 inches thick. The underlying material to a depth of 60 inches is pale yellow, calcareous loam.

Typically, the surface layer of the Bowbells soil is dark gray loam about 7 inches thick. The subsurface layer is dark grayish brown loam about 6 inches thick. The subsoil is friable clay loam about 35 inches thick. It is grayish brown and brown in the upper part and light gray and calcareous in the lower part. The underlying material to a depth of 60 inches is light gray, calcareous clay loam. In places the subsoil contains less clay.

Included with these soils in mapping are small areas of Cresbard and Tonka soils. These included soils make

up less than 15 percent of this map unit. Cresbard soils have a sodium-affected subsoil. They are slightly lower on the landscape than the Bowbells soil. The poorly drained Tonka soils are in basins.

The content of organic matter is moderate in the Williams and Zahl soils and high in the Bowbells soil. Fertility is medium in the Williams soil, low or medium in the Zahl soil, and high in the Bowbells soil. Permeability is moderate in the subsoil of the Williams and Bowbells soils and moderately slow in the underlying material. It is moderate in the upper part of the Zahl soil and moderately slow in the underlying material. Available water capacity is high in the Williams and Bowbells soils and moderate or high in the Zahl soil. The Bowbells soil has a water table at a depth of 4 to 6 feet during wet periods. Runoff is medium on the Williams and Zahl soils and slow on the Bowbells soil. The shrink-swell potential is moderate in all three soils.

Most of the acreage is cropland. These soils are suited to cultivated crops and to tame pasture and hay. Alfalfa, intermediate wheatgrass, and smooth brome are examples of suitable pasture plants. Wheat, corn, barley, and oats are the main crops. A high content of lime in the surface layer of the Zahl soil limits productivity by restricting the availability of plant nutrients. Controlling erosion on all three soils and improving the fertility of the Zahl soil are the main management needs. Minimizing tillage, leaving crop residue on the surface, and including grasses and legumes in the cropping sequence help to control erosion, conserve moisture, and improve fertility. Contour farming, grassed waterways, and terraces can help to control erosion, but in most areas the slopes are too short or too irregular for contouring and terracing.

No major hazards or limitations affect the use of these soils for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Williams soil, except for those that require an abundant supply of moisture. The Bowbells soil is especially well suited to the species that require an abundant supply of moisture. The high content of lime in the surface layer of the Zahl soil is a limitation. Trees and shrubs can be established on this soil, but optimum survival, growth, and vigor are unlikely.

The Williams and Zahl soils are suited to building site development, but the moderate shrink-swell potential is a limitation. Backfilling with sandy material, installing foundation drains, and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. Reinforcing the foundations and footings also helps to prevent this damage. Buildings should be designed so that they conform to the natural slope of the land. In some areas land shaping is needed.

The Williams and Zahl soils are suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption area helps to overcome a slow absorption rate. Land shaping and installing the distribution lines across the slope improve the efficiency of the absorption system.

The Bowbells soil is generally unsuitable as a site for buildings and septic tank absorption fields because it is subject to overland flow.

The Williams soil is in capability unit IIIe-2, Silty range site, and windbreak suitability group 3; the Zahl soil is in capability unit IVe-3, Thin Upland range site, and windbreak suitability group 8; the Bowbells soil is in capability unit IIc-3, Overflow range site, and windbreak suitability group 1.

Wt—Winship-Tonka silt loams. These deep, level and nearly level soils are on glacial lake plains. The somewhat poorly drained Winship soil is on toe slopes between and surrounding basins. The poorly drained Tonka soil is in the basins. It is ponded during spring runoff and after heavy rains. Areas of this map unit are long and narrow and range from 10 to 60 acres in size. They are 55 to 65 percent Winship soil and 20 to 30 percent Tonka soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Winship soil is dark gray silt loam about 7 inches thick. The subsurface layer also is dark gray silt loam. It is about 15 inches thick. The next layer is gray silty clay loam about 11 inches thick. The subsoil is gray and light brownish gray, friable silty clay loam about 15 inches thick. The underlying material to a depth of 60 inches is light gray silt loam.

Typically, the surface layer of the Tonka soil is gray silt loam about 9 inches thick. The subsurface layer is light gray silt loam about 9 inches thick. The subsoil is about 32 inches thick. It is firm. It is gray silty clay in the upper part and light brownish gray and light gray silty clay loam in the lower part. The underlying material to a depth of 60 inches is light gray silty clay loam.

Included with these soils in mapping are small areas of Aberdeen, Bearden, Beotia, and Harmony soils. These included soils make up less than 15 percent of this map unit. Aberdeen soils have a sodium-affected subsoil. They are in the higher positions on the landscape. Bearden soils have lime at or near the surface. They are in positions on the landscape similar to those of the Winship soil. The well drained Beotia

and moderately well drained Harmony soils are in the higher positions on the landscape.

The content of organic matter is high in the Winship and Tonka soils. Fertility also is high. Permeability is moderately slow in the upper part of the Winship soil and moderately slow or slow in the underlying material. It is slow in the Tonka soil. Available water capacity is high in both soils. During wet periods the water table is within a depth of 1 foot in the Tonka soil and is at a depth of 2 to 4 feet in the Winship soil. As much as 0.5 foot of water ponds on the Tonka soil. Runoff is slow on the Winship soil and ponded on the Tonka soil. The shrink-swell potential is moderate in the Winship soil and high in the Tonka soil.

Most areas are cultivated along with the surrounding areas. These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, Garrison creeping foxtail, intermediate wheatgrass, reed canarygrass, and smooth brome. The main crops are corn, wheat, oats, soybeans, and sunflowers. Ponding is a hazard on the Tonka soil. Wetness commonly delays farming during most years. Controlling runoff from the adjacent soils and using diversions and open drains reduce the wetness. Timely tillage and tillage practices that leave crop residue on the surface help to maintain fertility and tilth.

If these soils are used for range, compaction is a problem. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity. Many areas of the Tonka soil are potential sites for excavated ponds.

The Winship soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, and those that require an abundant supply of moisture grow especially well. The Tonka soil is generally unsuited to windbreaks and environmental plantings unless it is drained.

These soils are generally unsuited to building site development and most sanitary facilities because of the wetness and the ponding.

The Winship soil is in capability unit IIw-1, Overflow range site, and windbreak suitability group 1; the Tonka soil is in capability unit IVw-1, Wet Meadow range site, and windbreak suitability group 10.

Wy—Wyndmere fine sandy loam. This deep, somewhat poorly drained, level and nearly level soil is on glacial lake plains. Areas are irregular in shape and range from 5 to 80 acres in size. Slopes are smooth or slightly concave.

Typically, the surface layer is dark gray, calcareous fine sandy loam about 8 inches thick. The subsoil is gray and light gray, calcareous fine sandy loam about 23 inches thick. The underlying material to a depth of 60 inches is light brownish gray and light yellowish brown, calcareous loamy very fine sand.

Included with this soil in mapping are small areas of Arveson, Embden, and Tiffany soils. These soils make up less than 10 percent of this map unit. The poorly drained Arveson and Tiffany soils are on the lower parts of the landscape. Tiffany soils do not have free lime within a depth of 16 inches. The well drained and moderately well drained Embden soils are in the higher areas. They do not have free lime within a depth of 16 inches.

The content of organic matter is high in the Wyndmere soil, and fertility is medium. Permeability is moderately rapid. Available water capacity is low. During wet periods the water table is at a depth of 2 to 5 feet. Runoff is slow.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. The main crops are wheat, barley, and corn. A high content of lime in the surface layer limits the availability of plant nutrients and increases the susceptibility to wind erosion. Measures that control wind erosion and improve fertility are the main management needs. Examples are tillage practices that leave crop residue on the surface, a cropping sequence that includes grasses and legumes, field windbreaks, and stripcropping.

If this soil is used for range, wind erosion can be a problem unless an adequate plant cover is maintained. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum production.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, especially those that require an abundant supply of moisture.

This soil is generally unsuited to building site development and septic tank absorption fields because of the wetness.

This soil is in capability unit IIIe-14, Limy Subirrigated range site, and windbreak suitability group 1.

Wz—Wyndmere-Stirum fine sandy loams. These deep, level to gently undulating soils are on glacial lake plains. Slopes are 0 to 3 percent. The somewhat poorly drained Wyndmere soil is on the upper toe slopes, and the poorly drained Stirum soil is on the lower toe slopes and in microlows. Areas are irregular in shape and range from 10 to 300 acres in size. They are 45 to 55 percent Wyndmere soil and 30 to 40 percent Stirum soil. The two soils occur as areas so closely

intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Wyndmere soil is dark gray, calcareous fine sandy loam about 8 inches thick. The subsoil is gray and light gray, calcareous fine sandy loam about 23 inches thick. The underlying material to a depth of 60 inches is light brownish gray and light yellowish brown, calcareous loamy very fine sand.

Typically, the surface layer of the Stirum soil is very dark gray, calcareous fine sandy loam about 6 inches thick. The subsoil is friable, calcareous loam about 26 inches thick. It is dark gray and light brownish gray in the upper part and light gray in the lower part. The underlying material to a depth of 60 inches is light gray, calcareous loamy very fine sand and loamy fine sand.

Included with these soils in mapping are small areas of Borup and Stirum Variant soils. These included soils make up less than 15 percent of this map unit. Borup soils contain more silt and less sand than the Wyndmere soil. Also, they are in slightly lower positions in the landscape. The poorly drained Stirum Variant soils are in basins.

The content of organic matter is high in the Wyndmere soil and moderate in the Stirum soil. Fertility is medium in the Wyndmere soil and low in the Stirum soil. The Stirum soil has a sodium-affected subsoil. Tilth is poor in this soil. Permeability is moderately rapid in the Wyndmere soil. It is moderately slow in the subsoil of the Stirum soil and moderate to rapid in the underlying material. Available water capacity is low in both soils. During wet periods the water table is at a depth of 2 to 5 feet in the Wyndmere soil and 1 to 3 feet in the Stirum soil. Water ponds for short periods on the Stirum soil during these periods. Runoff is slow on the Wyndmere soil and very slow on the Stirum soil.

Most of the acreage supports native grasses and is used for grazing. Wind erosion can be a hazard on the Wyndmere soil unless an adequate plant cover is maintained. Compaction can be a problem on the Stirum soil. Restricted grazing during wet periods helps to prevent compaction and deterioration of tilth in the Stirum soil. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum production.

These soils are suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, pubescent wheatgrass, and smooth brome. Wheat, barley, and oats are the main crops. The dense, sodium-affected subsoil, the wetness, and the ponding are limitations in areas of the Stirum soil. A high content of lime in the surface layer of the Wyndmere soil restricts the availability of plant nutrients and increases the susceptibility to wind erosion. Measures that reduce wetness, improve fertility, and control wind erosion are the main management needs. Tillage practices that leave crop residue on the surface, a cropping sequence that includes grasses and legumes, and stripcropping improve fertility and help to control wind erosion. Chiseling or subsoiling increases the rate of water intake and improves tilth in the Stirum soil. Suitable drainage outlets generally are not available.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Wyndmere soil, and those that require an abundant supply of moisture grow especially well. The sodium-affected subsoil in the Stirum soil severely limits root penetration. Optimum growth, survival, and vigor are unlikely on this soil.

These soils are generally unsuited to building site development and septic tank absorption fields because of the wetness.

The Wyndmere soil is in capability unit IIIe-14, Limy Subirrigated range site, and windbreak suitability group 1; the Stirum soil is in capability unit IVw-2, Subirrigated range site, and windbreak suitability group 9.

ZaD—Zahl-Embden-Wabek Variant complex, 3 to 15 percent slopes. These deep, gently sloping to strongly sloping soils are on narrow ridges on moraines. The well drained Zahl soil is on the upper back slopes and shoulder slopes. The well drained Embden soil is on the lower back slopes. The excessively drained Wabek Variant soil is on shoulder slopes and summits. It is shallow or very shallow over gravelly sand. Scattered stones are on the surface in most areas of the Zahl and Wabek Variant soils. Areas of this map unit are generally long and narrow and range from 10 to 200 acres in size. They are 40 to 50 percent Zahl soil, 20 to 30 percent Embden soil, and 10 to 20 percent Wabek Variant soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Zahl soil is dark grayish brown, calcareous loam about 6 inches thick. The subsoil is light gray, friable, calcareous loam about 17 inches thick. The underlying material to a depth of 60 inches is pale yellow, calcareous loam.

Typically, the surface layer of the Embden soil is dark gray fine sandy loam about 7 inches thick. The subsurface layer also is dark gray fine sandy loam. It is about 9 inches thick. The subsoil is very friable fine sandy loam about 27 inches thick. The upper part is grayish brown, and the lower part is light gray and calcareous. The underlying material to a depth of 60 inches is light gray, calcareous very fine sandy loam. In places the soil is dark to a depth of less than 16 inches.

Typically, the surface layer of the Wabek Variant soil is dark grayish brown gravelly loam about 7 inches thick. The upper part of the underlying material is dark brown and pale brown, calcareous gravelly loamy sand and gravelly sand. The lower part to a depth of 60 inches is light yellowish brown, calcareous clay loam. In places clay loam is below a depth of 40 inches.

Included with these soils in mapping are small areas of Vida and Williams soils. These included soils make up less than 15 percent of this map unit. They have more clay in the subsoil than the Zahl soil. Vida soils are in positions on the landscape similar to those of the Zahl soil. Williams soils are on the slightly lower back slopes.

The content of organic matter is moderate in the Zahl and Embden soils and low in the Wabek Variant soil. Fertility is low or medium in the Zahl and Embden soils and low in the Wabek Variant soil. Permeability is moderate in the subsoil of the Zahl soil and moderately slow in the underlying material. It is moderately rapid in the Embden soil. It is very rapid in the upper part of the Wabek Variant soil and moderately slow in the underlying glacial till. Available water capacity is moderate or high in the Zahl soil and moderate in the Embden and Wabek Variant soils. During wet periods the Embden soil has a water table at a depth of 4 to 6 feet. Runoff is rapid on the Zahl soil and slow on the Embden and Wabek Variant soils. The shrink-swell potential is moderate in the Zahl soil and low in the Embden soil. It is low in the upper part of the Wabek Variant soil and moderate in the underlying glacial till.

Most of the acreage is in native grasses and is used for grazing. Productivity is limited on the Wabek Variant soil because it is droughty. Erosion can be a problem where the range is overgrazed. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

The Zahl and Wabek Variant soils are generally unsuited to cultivated crops, tame pasture and hay, and windbreaks and environmental plantings. The Zahl soil is too stony and steep, and the Wabek Variant soil is droughty. The Embden soil is suited to cultivated crops, tame pasture and hay, and windbreaks and environmental plantings, but it is subject to erosion and occurs only in small areas on the lower side slopes.

These soils generally are too steep and too stony for building site development and septic tank absorption fields. The better suited adjacent soils should be selected as sites for these purposes.

The Zahl soil is in capability unit VIe-3, Thin Upland range site, and windbreak suitability group 8; the Embden soil is in capability unit IVe-8, Sandy range site, and windbreak suitability group 1; the Wabek Variant soil is in capability unit VIs-4, Very Shallow range site, and windbreak suitability group 10.

ZdE—Zahl-Kloten-Edgeley complex, 9 to 35 percent slopes. These well drained, strongly sloping to steep soils are on the sides of entrenched drainageways in the uplands. The deep Zahl soil is on the summits and shoulder slopes. The shallow Kloten soil is on the middle and higher back slopes below the Zahl soil. The moderately deep Edgeley soil is on the lower back slopes below the Kloten soil. Areas are long and narrow and range from 15 to more than 200 acres in size. They are 35 to 45 percent Zahl soil, 20 to 30 percent Kloten soil, and 15 to 25 percent Edgeley soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Zahl soil is dark grayish brown, calcareous loam about 6 inches thick. The subsoil is light gray, friable, calcareous loam about 17 inches thick. The underlying material to a depth of 60 inches is pale yellow, calcareous loam. In places the dark surface layer is less than 6 inches thick.

Typically, the Kloten soil has a surface layer of dark gray clay loam about 6 inches thick. The underlying material to a depth of about 18 inches is light brownish gray and gray clay loam. The lower part is calcareous and has many medium and coarse shale chips. Below this to a depth of 60 inches is gray, bedded shale.

Typically, the surface layer of the Edgeley soil is dark grayish brown loam about 7 inches thick. The subsoil is friable clay loam about 17 inches thick. It is grayish brown in the upper part and light brownish gray in the lower part. Below this to a depth of 60 inches is light gray, bedded shale. In places the depth to shale is more than 40 inches.

Included with these soils in mapping are small areas of Brantford Variant, Tally, Vida, and Williams soils. These included soils make up less than 15 percent of this map unit. Brantford Variant soils have shaly gravelly sand at a depth of 14 to 20 inches. They are on the nearly level terraces. Tally, Vida, and Williams soils are on the summits above the Zahl soil. Tally soils contain more sand and less clay than the Zahl soil. Vida and Williams soils have more clay in the subsoil than the Zahl soil.

The content of organic matter is low to moderate in the Kloten soil and moderate in the Zahl and Edgeley soils. Fertility is low or medium in the Zahl and Kloten soils and medium in the Edgeley soil. Permeability is moderate in the subsoil of the Zahl soil and moderately slow in the underlying material. It is moderate above the shale in the Kloten and Edgeley soils. Available water

capacity is moderate or high in the Zahl soil, low in the Kloten soil, and low or moderate in the Edgeley soil. Runoff is rapid on all three soils. The shrink-swell potential is moderate.

Most areas support native grasses and are used for grazing. Water erosion can be a problem if the range is overgrazed. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

These soils generally are unsuited to cultivated crops, tame pasture and hay, windbreaks and environmental plantings, building site development, and sanitary facilities because of the slope.

The Zahl soil is in capability unit VIIe-3, Thin Upland range site, and windbreak suitability group 10; the Kloten soil is in capability unit VIIe-3, Shallow range site, and windbreak suitability group 10; the Edgeley soil is in capability unit VIe-1, Silty range site, and windbreak suitability group 10.

ZeA—Zell silt loam, 0 to 2 percent slopes. This deep, well drained, level and very gently sloping soil is on glacial lake plains. It is in areas where fill material has been excavated and the topsoil has been replaced. Areas are irregular in shape and range from 10 to 40 acres in size. Slopes are long and smooth.

Typically, the surface layer is dark gray, calcareous silt loam about 6 inches thick. Below this is a transitional layer of grayish brown, calcareous silt loam about 5 inches thick. The subsoil is light brownish gray, friable, calcareous silt loam about 7 inches thick. The underlying material to a depth of 60 inches is light gray and pale yellow, calcareous, varved silt loam. Many gray and yellowish brown relict mottles are in the underlying material. In some areas the soil has visible salts within a depth of 16 inches. In other areas, the surface layer is loam and the underlying material is clay loam.

Included with this soil in mapping are small areas of Great Bend, Putney, and Williams soils. These soils make up less than 15 percent of this map unit. They are in positions on the landscape similar to those of the Zell soil. Great Bend and Putney soils do not have lime in the surface layer. Also, Putney soils have visible salts within a depth of 20 inches. Williams soils contain more sand and clay than the Zell soil.

The content of organic matter is moderate in the Zell soil, and fertility is low or medium. Available water capacity is high. Permeability is moderate. Runoff is slow.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth brome. Wheat, corn, barley, and oats are the main crops. A high content of lime in the surface layer restricts the availability of plant nutrients. Maintaining or improving fertility and controlling erosion are the main management needs. Tillage practices that leave crop residue on the surface help to control erosion, improve fertility, and conserve moisture. Including grasses and legumes in the cropping sequence helps to maintain or improve fertility.

No major hazards or limitations affect the use of this soil for range. Proper stocking rates, timely deferment of grazing, and rotation grazing help to maintain maximum productivity.

This soil is suited to windbreaks and environmental plantings, but the high content of lime in the surface layer is a limitation. Trees and shrubs can be established, but optimum survival, growth, and vigor are unlikely.

This soil is suited to building site development. It is suited to septic tank absorption fields, but the restricted permeability is a limitation. Enlarging the absorption field helps to overcome a slow absorption rate.

This soil is in capability unit IIIe-5, Thin Upland range site, and windbreak suitability group 8.

ZgD—Zell-Great Bend silt loams, 6 to 25 percent slopes. These deep, well drained, moderately sloping to moderately steep soils are on glacial lake plains. The Zell soil is on shoulder slopes, and the Great Bend soil is on back slopes. Areas are generally long and narrow and range from 10 to 60 acres in size. They are about 50 to 60 percent Zell soil and 30 to 40 percent Great Bend soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Zell soil is dark gray, calcareous silt loam about 6 inches thick. Below this is a transitional layer of grayish brown, calcareous silt loam about 5 inches thick. The subsoil is light brownish gray, friable, calcareous silt loam about 7 inches thick. The underlying material to a depth of 60 inches is light gray and pale yellow, calcareous, varved silt loam. In some areas visible salts are within a depth of 16 inches.

Typically, the surface layer of the Great Bend soil is grayish brown silt loam about 8 inches thick. The subsoil is about 21 inches thick. It is friable. It is grayish brown silty clay loam in the upper part and pale yellow, calcareous silt loam in the lower part. The underlying material to a depth of 60 inches is light gray, light olive brown, and white, calcareous silt loam. It is varved with very fine sandy loam and silty clay. In places the soil contains less clay, more silt, and more very fine sand.

Included with these soils in mapping are small areas

of Huffton soils. These included soils make up less than 15 percent of this map unit. They have nests of salt and gypsum at or near the surface. They are in positions on the landscape similar to those of the Zell soil.

The content of organic matter is moderate in the Zell and Great Bend soils. Fertility is low or medium in the Zell soil and medium in the Great Bend soil. Available water capacity is high in both soils. Permeability is moderate in the Zell soil. It is moderate in the subsoil of the Great Bend soil and moderate to slow in the underlying material. Runoff is medium or rapid on the Zell soil and medium on the Great Bend soil. The shrink-swell potential is low in the Zell soil. It is moderate in the subsoil of the Great Bend soil and low in the underlying material.

Most of the acreage supports native grasses and is used for grazing. Erosion is a hazard unless an adequate plant cover is maintained. Reestablishing vegetation is difficult in eroded areas.

The Zell soil is generally unsuited to cultivated crops because of low fertility and the hazard of erosion. The Great Bend soil is suited to cultivated crops, but erosion is a hazard. Measures that control erosion are the main management needs. Improving the fertility of the Zell soil also is a management concern. A high content of lime in this soil restricts the availability of plant nutrients. Minimizing tillage, leaving crop residue on the surface, and including grasses and legumes in the cropping sequence help to control erosion, conserve moisture, and improve fertility. Contour farming, grassed waterways, and terraces can help to control erosion, but some areas are too narrow and the slopes are too short for contouring and terracing.

The Zell soil is generally unsuited to windbreaks and environmental plantings. The Great Bend soil is suited to these uses, but the slope is a limitation. Except for the species that require an abundant supply of moisture, all climatically suited trees and shrubs grow well. Where possible, planting on the contour can help to control erosion.

These soils are suited to most kinds of building site development, but the slope is a limitation. The buildings should be designed so that they conform to the natural slope of the land. In some areas land shaping is needed.

These soils generally are too steep for most sanitary facilities. Septic tank absorption fields should be installed in the less sloping areas. Enlarging the absorption area helps to overcome a slow absorption rate. Land shaping and installing the distribution lines across the slope improve the efficiency of the absorption system.

The Zell soil is in capability unit VIe-3, Thin Upland range site, and windbreak suitability group 10; the Great Bend soil is in capability unit IIIe-1, Silty range site, and windbreak suitability group 3.

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 Soil Conservation Service.

About 345,000 acres in Brown County, or nearly 31 percent of the total acreage, meets the soil requirements for prime farmland. Scattered areas of this land are throughout the county. Almost all of the acreage of prime farmland is used for crops. The main crops are corn, small grain, sunflowers, soybeans, and alfalfa.

The map units in Brown County that are considered prime farmland are listed in table 5. 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

and all soils that are frequently flooded during the growing season qualify for prime farmland only in areas where these limitations have been overcome by drainage measures or flood control. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not these limitations have been overcome by corrective measures.

Use and Management of the Soils

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

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and 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 recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help to prevent construction failures caused by unfavorable soil properties.

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

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

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

The soils in the survey area are assigned to various interpretive groups at the end of each map unit description and in some of the tables. The groups for each map unit also are shown in the section "Interpretive Groups," which follows the tables at the back of this survey.

Crops and Pasture

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

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

About 72 percent of the acreage in Brown County is used for cultivated crops or tame pasture and hay *(3)*. The major crops are corn, spring wheat, sunflowers, oats, barley, soybeans, and alfalfa. Winter wheat, corn for silage, sorghum, flax, and rye also are grown. Alfalfa is harvested mainly for hay; spring wheat, barley, winter wheat, sorghum, soybeans, and sunflowers are grown as cash crops; oats are grown as a cash crop and as livestock feed; and corn is harvested for both silage and grain.

The potential of the soils in Brown County for increased crop production is good. In addition to the reserve productive capacity of range, pasture, and tame hayland represented by this land, food production could be increased considerably by extending the latest crop production technology to all cropland in the county. This soil survey can greatly facilitate the application of such technology.

Water erosion is a problem on some of the cropland, hayland, and pasture in Brown County. Loss of the surface layer through erosion reduces the productivity of the soil and can result in the pollution of lakes and streams by sediment. Productivity is reduced when the more fertile surface layer is lost and part of the subsoil is incorporated into a plow layer. Loss of the surface layer is especially damaging on soils that have a claypan subsoil, such as Cavour, Turton, Nahon, and

Noonan soils, and on soils that have a thin surface layer, such as Buse, Zahl, and Zell soils. Erosion also reduces the productivity of soils that tend to be droughty, such as Brantford Variant and Renshaw soils. Controlling erosion minimizes the movement of sediment that can contain nutrients or herbicides to fence rows, ditches, shelterbelts, streams, lakes, and other nontarget areas. It also improves or maintains water quality for fish and wildlife, recreation, and municipal use.

A cropping system that includes grasses and legumes and that keeps a plant cover on the surface for extended periods holds soil losses to an amount that will not reduce the productive capacity of the soils. Leaving crop residue on the surface during the critical erosion period early in spring helps to protect the soil from wind and water erosion. The crop residue also adds organic matter to the soil, improves fertility and tilth, minimizes the movement of pesticides and nutrients across the landscape, and aids in the retention and absorption of rainfall.

Terraces, diversions, and contour stripcropping help to control erosion on the gently sloping and moderately sloping Beotia, Great Bend, Kranzburg, and Zell soils. Slopes are so short and irregular that contour farming and terraces are not practical in most areas of the sloping Barnes, Forman, Vida, and Williams soils. On these soils a cropping system that keeps a substantial plant cover on the surface is needed.

Minimizing tillage and leaving crop residue on the surface increase the rate of water infiltration and reduce runoff and erosion. No-till farming is also an effective erosion-control method. These practices in combination with grassed waterways are suitable on most of the soils in the survey area.

Wind erosion is a hazard on many of the soils in the county. The hazard of wind erosion is especially severe on soils that have a surface layer of fine sandy loam or loamy fine sand, such as Egeland, Embden, Hamar, Hecla, Maddock, Tally, Towner, Ulen, and Wyndmere soils. Soils that have a high content of lime in the surface layer, such as Bearden, Buse, Colvin, Divide, Glyndon, Hamerly, Rondell, Vallers, and Zell soils, also are highly susceptible to wind erosion. They can be damaged in a few hours if winds are strong and the soils are dry and have no plant cover or surface mulch. An adequate plant cover, a cover of crop residue, stripcropping, and a rough surface minimize wind erosion on these soils. Including grasses and legumes in the cropping system, planting windbreaks of suitable trees and shrubs, and leaving strips of unharvested crops also are effective in reducing the hazard of wind erosion.

Information about the measures that control erosion on each kind of soil is contained in the Technical Guide, available in the local office of the Soil Conservation Service.

Wetness frequently limits production on the poorly drained Colvin, Nishon, Tonka, and Vallers soils. Open ditches or tile drains may increase productivity if outlets are available; however, the benefits of these wetter areas should be considered before a drainage system is installed. The moderately well drained Aastad, Bowbells, Brookings, LaDelle, La Prairie, and Svea soils on flood plains and flats and in upland swales receive stream overflow and runoff from adjacent uplands. In most years, drainage is adequate and crops benefit from the additional moisture. Artificial drainage is rarely needed on these soils. During wet years, however, spring planting and tillage are delayed.

Soil fertility should be maintained in order to maximize yields. On soils that have a high content of lime in the surface layer, such as Bearden, Borup, Hamerly, Colvin, Divide, Glyndon, and Vallers soils, the kinds and amounts of nutrients needed generally differ from the kinds and amounts needed on soils that do not have lime in the surface layer. Including grasses and legumes in the cropping system improves fertility in the soils that have a high content of lime. On all soils additions of nutrients or organic wastes should be based on the results of soil tests, on the needs of the crop, and on the expected level of yields. The Cooperative Extension Service can help in determining the kinds and amounts of nutrients needed. Nutrients should be applied in a timely manner, and topography, tillage, irrigation, crop residue management, depth to the water table, and proximity to surface water should be considered in planning a nutrient management program. The Soil Conservation Service can assist in the development of a nutrient management plan.

Soil tilth affects the germination of seeds and the infiltration of water into the soil. Soils with good tilth are granular and porous. If tilled when wet, Harmony and Peever soils tend to be very cloddy when dry. As a result of the cloddiness, preparing a good seedbed is difficult. These soils dry slowly in the spring and cannot be easily tilled. Tilth also is poor in claypan soils, such as Cavour, Exline, Miranda, Nahon, and Turton soils. Selecting a proper time for tillage, including grasses and legumes in the cropping system, and incorporating crop residue into the soil improve tilth and increase the rate of water infiltration.

Field crops suited to the soils and climate of the survey area include small grain and row crops. Oats, barley, and spring wheat are the main small grain crops. Flax, winter wheat, and rye are also grown. Corn,

soybeans, and sunflowers are the main row crops, and smaller amounts of sorghum are grown. About 25 percent of the corn commonly is harvested for silage.

All of the commonly grown and climatically adapted crops are suited to deep, well drained or moderately well drained soils, such as Aastad, Barnes, Beotia, Brookings, Eckman, Forman, Gardena, Great Bend, Harmony, Kranzburg, LaDelle, La Prairie, Putney, Svea, Vida, and Williams soils. Fordville and Renshaw soils are better suited to early maturing small grain than to the deeper rooted crops, such as corn and alfalfa, because the porous underlying material limits the available water capacity and restricts root penetration. The Hecla, Maddock, Tally, Egeland, Embden, Hamar, and Towner soils, which are subject to wind erosion, also are better suited to small grain than to row crops because the small grain provides better protection against wind erosion.

The pasture plants that are best suited to the climate and to most of the soils in the survey area include alfalfa, intermediate wheatgrass, and smooth brome. Soils that tend to be droughty, such as Brantford Variant and Renshaw soils, are well suited to crested wheatgrass. This grass and other bunch grasses should not be planted in areas where the slope is more than 6 percent because erosion is a hazard. Soils that have a dense claypan subsoil, such as Noonan soils, are suited to pubescent wheatgrass. On the poorly drained Heil, Nishon, Tonka, and Vallers soils and the very poorly drained Parnell soils, the choice of pasture plants is limited to water-tolerant species, such as Garrison creeping foxtail and reed canarygrass.

If the pasture is overgrazed, the grasses lose vigor and die and are usually replaced by annual grasses and weeds. Proper stocking rates, timely deferment of grazing, and applications of fertilizer help to keep the pasture in good condition.

Each soil in the survey area has been assigned to a pasture suitability group. These groups are based primarily on the suitability of the soils for certain pasture species, management needs, and potential productivity. They are listed in the section "Interpretive Groups," which follows the tables at the back of this survey. Detailed interpretations for each pasture suitability group in the survey area are provided in the Technical Guide, which is available in the local office of the Soil Conservation Service.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. 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 moisture conservation measures, crop rotation, 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 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. 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 and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit *(11)*. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are

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

Class I soils have few limitations that restrict their use.

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

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

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

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

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

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

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

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main 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, wildlife habitat, or recreation.

Capability units are soil groups within a subclass. The soils in a capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-4 and IIIe-6.

The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the section "Interpretive Groups," which follows the tables at the back of this survey.

Rangeland

Arnold G. Mendenhall, range conservationist, Soil Conservation Service, prepared this section.

Rangeland supports native vegetation suitable for grazing or browsing. It includes areas where native vegetation has been reestablished. The vegetation is mainly grasses, grasslike plants, forbs, or shrubs. The amounts and kinds of native vegetation grown in any one area are determined by the soil, topography, climate, past use, and management.

All of the area that is now Brown County was rangeland before the first permanent settlers arrived. Currently, about 22 percent of the county supports native vegetation. This rangeland supplies a major portion of the forage for livestock. Approximately 53 percent of the farm and ranch income in the county is derived from the sale of livestock and livestock products *(9)*. Most of the ranches are cow-calf operations, some are yearling operations, and some are a combination of cows and yearlings. The combinations permit greater flexibility in adjusting livestock numbers during periods of drought. The rangeland generally is grazed from May through October. The forage provided by rangeland generally is supplemented by crop aftermath and tame pasture plants, such as intermediate wheatgrass and smooth brome. In winter it is supplemented by protein concentrate and hay.

The survey area is part of the mixed grass prairie. The native vegetation is dominated by mid grasses and forbs, but tall and short grasses and forbs are interspersed with these plants. The mixed grass prairie consists of cool- and warm-season plants, which provide good-quality forage throughout the growing season. The cool-season plants grow mostly during April, May, and June and the warm-season plants during June, July, and August. The cool-season grasses may start growing again in September and October if autumn rainfall is adequate.

The native vegetation in some parts of the county is producing below its potential because of past management practices. The tall grasses and some of the mid grasses have been replaced by less desirable plants. The result is a reduction in the total amount of available forage. In most areas, however, enough of the original plants remain for reestablishment of the high-quality plants through good grazing management.

Range Sites and Condition Classes

Different kinds of soil vary in their capacity to produce native vegetation. 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. Soils that produce approximately the same kinds, amounts, and proportions of native vegetation make up a range site. The potential native vegetation on a range site is the stabilized plant community that the site is capable of producing. It consists of the plants that were growing on the site when the region was settled. This plant community maintains itself and changes very little as long as the environment remains unchanged. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map.

The plants within the native plant community are sometimes grouped as decreasers, increasers, or invaders, depending on their response to grazing pressure. *Decreasers* are plants that respond to overgrazing by decreasing in extent. They generally are the most productive plants and the ones most preferred by grazing animals. *Increasers* are plants that respond to grazing pressure, at least initially, by increasing in amount as the more desirable decreaser plants become less extensive. Increasers generally are less productive and less preferred by grazing animals. *Invaders* are plants that are not part of the original plant community but invade the plant community because of continued overgrazing or some other kind of disturbance. Some invader plants have little value for grazing.

Because plants do not respond in the same manner to different influences, a plant may be a decreaser on some range sites but an increaser on others. A cool-season plant, for example, may be a decreaser if the site is grazed only during the spring but would be an increaser if the same site were grazed only during the summer. The reverse would be true for the more preferred warm-season plants. Restricting grazing to the spring would cause the warm-season plants to increase in abundance, and restricting grazing to the summer would cause them to decrease.

Table 7 shows, for nearly all of the soils, the range site and the potential annual production of vegetation in favorable, average, and unfavorable years. *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 exposure, amount of shade, recent rains, and unseasonable dry periods.

Range management helps to determine the capacity of the rangeland to produce forage for livestock and game animals and to provide wildlife habitat, water, and watershed protection. The primary objective of good range management is to keep the range in excellent or good condition. The main management concern is responding to important changes in the plant community on a range site.

Range condition is determined by comparing the present vegetation on a range site with the potential native plant community for the site. Four range condition classes are recognized. The range site is in excellent condition if 76 to 100 percent of the present vegetation is the same kind as the potential native vegetation; in good condition if the percentage is 51 to 75; in fair condition if the percentage is 26 to 50; and in poor condition if the percentage is 25 or less. The potential production of rangeland depends on the range site, the range condition, and the moisture available to plants during the growing season.

Measures that maintain or improve the range condition are needed on all of the rangeland in the survey area. They include proper stocking rates and rotation grazing or deferred grazing programs, which allow for the proper sequence of grazing and provide rest periods that maintain or improve the vigor of the key plants. Good range management may also include range seeding, fencing, and measures that provide water for livestock.

The survey area has 19 range sites. These are Clayey, Claypan, Closed Depression, Limy Subirrigated, Overflow, Saline Lowland, Saline Subirrigated, Sands, Sandy, Shallow, Shallow to Gravel, Shallow Marsh, Silty, Subirrigated, Thin Claypan, Thin Upland, Very Shallow, Wetland, and Wet Meadow. The paragraphs that follow describe the range sites in the survey area.

Clayey range site. The potential native vegetation on this site is dominated by mid prairie grasses interspersed with a variety of forbs. Green needlegrass and western wheatgrass, which are cool-season grasses, make up about 60 percent of the vegetation in about equal proportions. Warm-season grasses make up about 35 percent, including sideoats grama, which makes up 15 percent; little bluestem and big bluestem, 10 percent; and blue grama and buffalograss,

5 percent. Sedges make up about 5 percent of the vegetation, and forbs, such as heath aster, prairie coneflower, scarlet globemallow, and yarrow, make up the rest.

The major management concern on this site is maintaining the extent of the most productive plants. Green needlegrass, sideoats grama, little bluestem, and big bluestem lose their productive capacity after continued overgrazing because the livestock prefer these plants. As the extent of these plants decreases, the extent of western wheatgrass initially increases. After continuous overgrazing, however, the extent of this species decreases. If overgrazing continues, the more productive plants are replaced by blue grama, buffalograss, sedges, and weeds. The extent of the most productive plants can be maintained by proper stocking rates and by a deferred grazing or rotation grazing program, which provides rest periods during the growing seasons of the desirable plants.

Claypan range site. The potential native vegetation on this site is dominated by mid and short prairie grasses interspersed with a variety of forbs. Green needlegrass and western wheatgrass, which are cool-season grasses, make up about 55 percent of the vegetation in about equal proportions. Needleandthread makes up about 10 percent of the vegetation. Warm-season grasses, such as blue grama, buffalograss, and sideoats grama, make up about 25 percent of the vegetation. Sedges make up about 5 percent, and forbs, such as heath aster, scarlet gaura, scarlet globemallow, and sageworts, make up the rest.

The major management concern on this site is maintaining the extent of the most productive plants. Green needlegrass, sideoats grama, and western wheatgrass lose their productive capacity after continued overgrazing because the livestock prefer these plants. The more productive plants are replaced by blue grama, buffalograss, sedges, and weeds. The result is low forage production. The extent of the most productive plants can be maintained by proper stocking rates and by a deferred grazing or rotation grazing program, which provides rest periods during the growing season of the desirable plants. Restricted grazing during wet periods helps to prevent surface compaction and the deterioration of tilth.

Closed Depression range site. The potential native vegetation on this site is dominated by western wheatgrass, which makes up about 70 percent of the vegetation. Sedges, rushes, buffalograss, and inland saltgrass make up about 20 percent. Forbs, such as dock and smartweeds, make up the rest. This site becomes excessively wet or ponded during wet periods and is droughty during dry periods.

The major management concern on this site is maintaining the extent of the most productive plants. Continued overgrazing reduces the production of western wheatgrass, and the trampling of livestock aggravates the poor drainage on the site. Weeds and short grasses, such as saltgrass and Kentucky bluegrass, increase as the extent of the western wheatgrass decreases. The result is low forage production. The extent of the most productive plants can be maintained by proper stocking rates and by a rotation grazing or deferred grazing program, which provides rest periods during the growing season of the desirable plants. Restricted grazing during wet periods helps to prevent surface compaction and the deterioration of tilth.

Limy Subirrigated range site. The potential native vegetation on this site is dominated by warm-season, mid and tall grasses. Little bluestem makes up about 45 percent of the vegetation. A combination of big bluestem, indiangrass, and switchgrass makes up about 20 percent, and sideoats grama, about 10 percent. Green needlegrass and western wheatgrass, which are cool-season grasses, make up about 15 percent of the vegetation in about equal proportions. Sedges and rushes make up about 5 percent, and forbs, such as dotted gayfeather, goldenrods, and yarrow, make up the rest. This site is less productive than a Subirrigated site because of the seasonal nature of the water table and the high content of lime in the soils.

The major management concern on this site is maintaining the extent of the most productive plants. Big bluestem, indiangrass, switchgrass, and green needlegrass lose their productive capacity and thin out after continuous grazing because the livestock prefer these plants. As the extent of these plants decreases, the extent of little bluestem, sideoats grama, and western wheatgrass initially increases. After continuous overgrazing, however, little bluestem, sideoats grama, and western wheatgrass also decrease in extent. If overgrazing continues, the more productive plants are replaced by blue grama, bluegrass, annual bromes, sedges, and weeds. The result is low forage production. The extent of the most productive plants can be improved and maintained by proper stocking rates and by a rotation grazing or deferred grazing program, which provides rest periods during the growing season of these plants.

Overflow range site. The potential native vegetation on this site is dominated by warm-season, mid and tall grasses. Big bluestem makes up about 55 percent of the vegetation. Switchgrass, little bluestem, and

sideoats grama make up about 20 percent. Green needlegrass and western wheatgrass, which are cool-season grasses, make up about 15 percent of the vegetation in about equal proportions. Sedges and rushes make up about 5 percent. Forbs, such as heath aster, goldenrods, and yarrow, and shrubs, such as rose, leadplant, and chokecherry, make up the rest.

The major management concern on this site is maintaining the extent of the most productive plants. Big bluestem, switchgrass, and green needlegrass lose their productive capacity and thin out after continuous grazing because the livestock prefer these plants. As the extent of these plants decreases, the extent of little bluestem, sideoats grama, and western wheatgrass initially increases. After continuous overgrazing, however, little bluestem, sideoats grama, and western wheatgrass also decrease in extent. If overgrazing continues, the more productive plants are replaced by blue grama, bluegrass, annual bromes, sedges, and weeds. The result is low forage production. The extent of the most productive plants can be improved and maintained by proper stocking rates and by a rotation grazing or deferred grazing program, which provides rest periods during the growing season of these plants.

Saline Lowland range site. The potential native vegetation on this site is a combination of mid and tall prairie grasses. Western wheatgrass, which is a cool-season grass, makes up about 35 percent of the vegetation. Alkali cordgrass makes up about 30 percent, and Nuttall alkaligrass makes up about 10 percent. Both are warm-season grasses. Sedges, rushes, and inland saltgrass make up about 20 percent of the vegetation. Forbs, such as seepweed and silverscale saltbush, make up the rest. This site has a seasonal high water table.

The major management concern on this site is maintaining the extent of the most productive plants. Continued overgrazing reduces the production of western wheatgrass and Nuttall alkaligrass. As the extent of these plants decreases, inland saltgrass and foxtail barley become the principal plants on the site. The result is low forage production. The extent of the most productive plants can be maintained by proper stocking rates and by a rotation grazing or deferred grazing program, which provides rest periods during the growing season of these plants. Restricted grazing during wet periods helps to prevent surface compaction and the deterioration of tilth.

Saline Subirrigated range site. The potential native vegetation on this site is an excellent stand of warm-season, tall and mid grasses. A combination of big bluestem, indiangrass, and switchgrass makes up about 60 percent of the vegetation. Little bluestem makes up 20 percent; cordgrass and inland saltgrass, 10 percent; and sedges and forbs, 10 percent.

The major management concern on this site is maintaining the extent of the most productive plants. This is a very fragile plant community. Big bluestem, little bluestem, indiangrass, and switchgrass rapidly lose their productive capacity and thin out after continuous grazing because the livestock prefer these plants. As the extent of these plant decreases, inland saltgrass and foxtail barley become the principal plants on the site. Low forage production is the result. The extent of the most productive grasses can be improved or maintained by proper stocking rates and by a deferred grazing or rotation grazing program, which provides rest periods during the growing season for the desired plants.

Sands range site. The potential native vegetation on this site is dominated by warm-season, mid and tall grasses. Sand bluestem and prairie sandreed make up about 50 percent of the vegetation. A combination of switchgrass and little bluestem makes up about 15 percent. Needleandthread, which is a cool-season grass, makes up about 5 percent. Sand dropseed, Scribner panicum, blue grama, and sedges make up about 10 percent. Forbs, such as stiffleaf sunflower, eriogonum, scurfpea, and prairie-clover, make up about 10 percent. Shrubs, such as leadplant, rose, yucca, and sandcherry, make up the rest.

The major management concern on this site is maintaining the extent of the most productive plants. Sand bluestem, switchgrass, little bluestem, stiffleaf sunflower, leadplant, and rose lose their productive capacity and thin out after continuous grazing because the livestock prefer these plants. As the extent of these plants decreases, the extent of prairie sandreed, needleandthread, and sand dropseed initially increases. After continuous overgrazing, however, prairie sandreed, needleandthread, and sand dropseed also decrease in extent. If overgrazing continues, the more productive plants are replaced by blue grama, sedges, and weeds. The result is low forage production. Overgrazing can also result in bare areas, on which the hazard of wind erosion is severe. The extent of the most productive plants can be improved and maintained by proper stocking rates and by a rotation grazing or deferred grazing program, which provides rest periods during the growing season of the key plants.

Sandy range site. The potential native vegetation on this site is dominated by warm-season, mid and tall grasses. A combination of prairie sandreed, little bluestem, and sand bluestem or big bluestem makes up

about 55 percent of the vegetation. Cool-season grasses, such as needleandthread, western wheatgrass, and Canada wildrye, make up about 20 percent. Sideoats grama, blue grama, and sedges make up about 10 percent. Forbs, such as heath aster, scurfpea, false boneset, and fringed sagewort, make up about 10 percent. Shrubs, such as leadplant and rose, make up the rest.

The major management concern on this site is maintaining the extent of the most productive plants. Sand bluestem or big bluestem, little bluestem, leadplant, and rose lose their productive capacity and thin out after continuous grazing because the livestock prefer these plants. The extent of prairie sandreed, needleandthread, western wheatgrass, and sideoats grama initially increases as the other plants thin out. After continuous overgrazing, however, prairie sandreed, needleandthread, western wheatgrass, and sideoats grama also decrease in extent. If overgrazing continues, the more productive plants are replaced by blue grama, sedges, bluegrasses, and weeds. The result is low forage production. The extent of the most productive plants can be improved and maintained by proper stocking rates and by a rotation grazing or deferred grazing program, which provides rest periods during the growing season of the desirable plants.

Shallow range site. The potential native vegetation on this site is a mixture of warm- and cool-season, mid grasses. Little bluestem is the dominant warm-season species. It makes up about 25 percent of the vegetation. Other warm-season grasses on this site include sideoats grama, plains muhly, and blue grama. These species make up about 20 percent of the vegetation. Needlegrasses, which are the dominant cool-season species, make up about 25 percent of the vegetation. Other cool-season grasses and grasslike species on this site include western wheatgrass and sedges. These species make up about 20 percent of the vegetation. Forbs, such as blacksamson, dotted gayfeather, and prairie-clover, make up about 5 percent of the vegetation. Shrubs, such as leadplant and wild rose, also make up about 5 percent.

The major management concern on this site is maintaining the extent of the most productive grasses. Little bluestem and needlegrasses lose their productive capacity and thin out after continuous overgrazing because the livestock prefer these plants. The extent of western wheatgrass and sideoats grama initially increases as the other plants thin out. If overgrazing continues, the more productive plants are replaced by short grasses, such as blue grama and buffalograss. The extent of threadleaf sedge, a grasslike species, also increases. The result is low forage production. The extent of the most productive grasses can be increased or maintained by proper stocking rates and by a rotation grazing or deferred grazing program, which provides rest periods during the growing season of the desirable plants.

Shallow to Gravel range site. The potential native vegetation on this site is mid prairie grasses. Needleandthread, which is a cool-season grass, makes up about 30 percent of the vegetation. Warm-season grasses, such as little bluestem, plains muhly, sideoats grama, prairie dropseed, blue grama, and hairy grama, make up about 50 percent of the vegetation. Sedges, forbs, and shrubs make up about 20 percent.

The major management concern on this site is maintaining the extent of the most productive grasses. Needleandthread, little bluestem, plains muhly, sideoats grama, and prairie dropseed thin out after continuous grazing. When these grasses decrease in extent, sedges, blue grama, and hairy grama increase. If overgrazing continues, the productivity of the site is greatly reduced. The extent of the most productive grasses can be maintained by proper stocking rates and by a rotation grazing or deferred grazing program, which provides rest periods during the growing season of the desirable plants.

Shallow Marsh range site. This site is ponded in spring and early summer. The potential native vegetation is water-tolerant, tall prairie grasses and sedges. Bluejoint reedgrass and slough sedge make up about 70 percent of the vegetation. Cattails, common spikesedge, prairie cordgrass, and reedgrass make up about 20 percent, and forbs, such as smartweed and waterplantain, make up about 10 percent.

The major management concern on this site is maintaining the extent of the most productive plants. After continuous overgrazing, bluejoint reedgrass and slough sedge are replaced by spikesedge and other grasslike plants. An increase in the abundance of the less palatable vegetation results in a loss of available forage. The extent of the most productive plants can be maintained by proper stocking rates and by a deferred grazing program, which provides rest periods during the growing season of the desirable plants.

Silty range site. The potential native vegetation on this site is tall and mid grasses and a large quantity of forbs. Cool-season grasses, such as green needlegrass, porcupinegrass, and bearded wheatgrass, make up about 25 percent of the vegetation. Warm-season grasses, such as little bluestem, big bluestem, prairie dropseed, switchgrass, and indiangrass, make up about 55 percent of the vegetation. Forbs, such as

blacksamson, dotted gayfeather, stiff sunflower, heath aster, and prairie-clover, and shrubs, such as leadplant, rose, and western snowberry, make up about 20 percent.

The major management concern on this site is maintaining the extent of the most productive grasses. After continuous grazing, big bluestem, indiangrass, prairie dropseed, porcupinegrass, and green needlegrass decrease in extent because the livestock prefer these plants. The extent of little bluestem and sideoats grama initially increases after continuous grazing. After continuous overgrazing, however, short grasses, such as blue grama, annual bromes, and Kentucky bluegrass, become the dominant species. The result is low forage production. The extent of the most productive grasses can be increased or maintained by proper stocking rates and by a deferred grazing or rotation grazing program, which provides rest periods during the growing season of the desirable plants.

Subirrigated range site. The potential native vegetation on this site is dominantly warm-season, tall grasses. Big bluestem, which is the dominant warm-season grass, makes up about 60 percent of the vegetation. Prairie cordgrass, switchgrass, indiangrass, and little bluestem make up about 20 percent. Forbs, such as American licorice, Maximilian sunflower, downy gentian, Canada milkvetch, heath aster, and Missouri goldenrod, make up about 20 percent.

The major management concern on this site is maintaining the extent of the most productive tall grasses. After continuous grazing, big bluestem, indiangrass, switchgrass, and Maximilian sunflower and other forbs decrease in extent because the livestock prefer these plants. The extent of little bluestem, sideoats grama, and sedges initially increases after continuous grazing. After continuous overgrazing, however, short grasses, such as Kentucky bluegrass and downy brome, and sedges become the dominant plants. The result is low forage production. The extent of the most productive tall grasses can be maintained by proper stocking rates and by a rotation grazing or deferred grazing program, which provides rest periods during the growing season of the desirable plants.

Thin Claypan range site. The potential native vegetation on this site is a mixture of mid and short grasses. Western wheatgrass, which is the principal mid grass, makes up about 60 percent of the vegetation, and blue grama, the dominant short grass, makes up about 25 percent. The site also has smaller quantities of buffalograss, saltgrass, and sedges. Forbs, such as sageworts, heath aster, broom snakeweed, and woody plantain, generally make up less than 10 percent of the vegetation. The dominant shrub is pricklypear, but it makes up only a small percentage of the plant community.

The major management concern on this site is maintaining the extent of the most productive grasses. After continuous overgrazing, western wheatgrass is replaced by blue grama, buffalograss, and saltgrass. A considerable amount of the ground is bare, especially during dry periods, and weeds are common during wet periods. The most productive grasses can be maintained by proper stocking rates and by a rotation grazing or deferred grazing program, which provides rest periods during the growing season of the desirable plants.

Thin Upland range site. The potential native vegetation on this site is tall and mid grasses and a large number of forbs. Warm-season grasses make up about 70 percent of the vegetation. Of these, little bluestem makes up about 30 percent; prairie dropseed, big bluestem, switchgrass, indiangrass, and plains muhly, 30 percent; and sideoats grama, 10 percent. Cool-season grasses, such as green needlegrass, porcupinegrass, and needleandthread, make up about 10 percent of the vegetation. Forbs, such as pasqueflower, dotted gayfeather, and blacksamson, and woody plants, such as leadplant and rose, make up about 20 percent.

The major management concern on this site is maintaining the extent of the most productive grasses. Indiangrass, prairie dropseed, big bluestem, porcupinegrass, and plains muhly lose their productive capacity and thin out after continuous grazing because the livestock prefer these plants. The extent of little bluestem, sideoats grama, and needleandthread initially increases as the other grasses thin out. After continuous overgrazing, short grasses, such as blue grama, become the dominant plants. The result is low forage production. The extent of the most productive grasses can be increased or maintained by proper stocking rates and by a deferred grazing or rotation grazing program, which provides rest periods during the growing season of the desirable plants.

Very Shallow range site. The potential native vegetation on this site is mid and short grasses. Needleandthread, plains muhly, and sideoats grama, the dominant mid grasses, make up about 50 percent of the vegetation. Short grasses, such as blue grama and hairy grama, and sedges make up about 30 percent. Forbs, such as dotted gayfeather, blacksamson, and sagewort, and shrubs, such as leadplant and rose, make up about 20 percent.

The main management concern on this site is

maintaining a good stand of grasses. After continuous overgrazing, the site rapidly deteriorates to a stand of grama grasses, threadleaf sedge, and a few unpalatable forbs. If overgrazing continues, the stand of short grasses may thin out and much of the site is susceptible to erosion. A productive cover of grasses can be maintained by proper stocking rates and by a deferred grazing or rotation grazing program, which provides rest periods during the growing season of the desirable plants.

Wetland range site. This range site has the potential to produce a luxuriant stand of grasses that tolerate a high water table. Areas of this site are often covered by water during the spring, which restricts their use to summer and fall. Prairie cordgrass is the dominant species. It makes up about 70 percent of the vegetation. Other grasses and grasslike plants, such as reedgrasses, reed canarygrass, switchgrass, Canada wildrye, bluegrasses, and sedges, generally make up less than 25 percent of the vegetation. Forbs, such as asters, waterhemlock, and giant goldenrod, and shrubs, such as indigo amorpha and willows, are on the site in small numbers.

The major management concern on this site is maintaining the extent of the most productive plants. If the site is continuously overgrazed, the stand of climax grasses loses vigor and density and sedges, rushes, Kentucky bluegrass, and saltgrass increase in extent or invade the site. The result is a less productive plant community. The most productive grasses can be maintained by proper stocking rates and by a rotation grazing or deferred grazing program, which provides rest periods during the growing season of the desirable plants.

Wet Meadow range site. This range site has the potential to produce a luxuriant stand of sedges and mid or tall grasses. Sedges are the dominant species. They make up about 50 percent of the vegetation. Tall grasses, such as reedgrasses, prairie cordgrass, and reed canarygrass, make up about 30 to 40 percent of the vegetation. Mid grasses, such as western wheatgrass and bluegrasses, are on the site but are not dominant. Forbs, such as smartweed, aster, and milkweed, are common but generally make up less than 10 percent of the vegetation. Willows are also on the site in small numbers.

The major management concern on this site is maintaining the extent of the most productive grasses and sedges. In some years, areas of this site are not usable during spring and early summer because the surface is ponded for about 4 to 8 weeks following periods of snowmelt or heavy rainfall. Surface compaction can be a problem if livestock are allowed to use the site during wet periods. Allowing the livestock to graze only after the soils have dried out helps to minimize compaction. After continuous overgrazing, the tall grasses and the more palatable sedges decrease in extent; the less palatable sedges, spikesedge, and rushes increase; and weedy grasses, such as foxtail barley, invade the site. As a result, forage production is greatly reduced. The most productive grasses and sedges can be maintained by proper stocking rates and a rotation grazing or deferred grazing program, which provides rest periods during the growing season of the desirable plants.

Native Woodland, Windbreaks, and Environmental Plantings

Native trees and shrubs grow on only about 7,400 acres in Brown County. They generally grow as clumps and thickets in swales, in drainageways or in areas adjacent to drainageways and sloughs, and on bottom land along the Elm and James Rivers. The early settlers used the native trees and shrubs for fuel and food. Currently these trees and shrubs are used mainly for wildlife habitat, watershed protection, and recreational purposes.

Scattered individual plants or clumps of bur oak, common chokecherry, hawthorn, western snowberry, and wild rose are common on the Bowbells, Svea, and Edgeley soils in swales and on the breaks of major streams in the glacial till uplands. Along the Elm River, scattered individual plants or clumps of American elm, American plum, boxelder, bur oak, common chokecherry, green ash, peachleaf willow, plains cottonwood, and western snowberry are common on the LaDelle soils. Scattered trees and shrubs in areas of the Lamoure, Ludden, Playmoor, and Zell soils on flood plains and breaks near the James River are American elm, American plum, boxelder, bur oak, common chokecherry, common hackberry, green ash, peachleaf willow, plains cottonwood, sandbar willow, and western snowberry. Peachleaf willow, plains cottonwood, and sandbar willow are common on the margins of natural lakes and wetlands throughout the county. Russian olive, an introduced species, is common on all of the soils in the survey area.

Windbreaks have been planted since the days of the early settlers. They were planted primarily to protect farmsteads and livestock. Since the late 1930's and early 1940's, many field windbreaks have been planted in the sandy northeastern part of the county to control wind erosion. These field windbreaks and stripcropping were the major erosion-control measures. Windbreaks are still needed on thousands of acres in the county,

and some existing windbreaks need to be renovated. Several rows of low- and high-growing, broadleaf and coniferous trees 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 insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 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.

Grazing is detrimental to windbreaks and environmental plantings because it results in soil compaction and the loss of the lower branches of the trees and shrubs. The compaction retards plant growth, and removal of the lower branches reduces the effectiveness of the windbreaks. Weeds and insects also inhibit growth. Clean cultivation and applications of herbicide help to control weeds. Fallowing a year before planting helps to provide a reserve supply of the moisture necessary for the establishment of the seedlings. On soils that are susceptible to wind erosion, such as Hecla, Maddock, Towner, and Ulen soils, the site should be prepared in the spring so that it is not exposed to wind erosion during the winter.

At the end of each description under the heading "Detailed Soil Map Units," the soil has been assigned to a windbreak suitability group. These groups are based primarily on the suitability of the soil for the locally adapted species, as is indicated by their growth and vigor. Detailed interpretations for each windbreak suitability group in the county are provided in the Technical Guide, which is available in the local office of the Soil Conservation Service.

Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

The soils of the survey area are rated in table 9 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 also are 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 9, 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 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

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

Connie M. Vicuna, biologist, Soil Conservation Service, helped prepare this section.

Soils affect the kind and amount of vegetation that is available to wildlife for 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.

The most abundant wildlife species in Brown County are those that inhabit wetland areas and cultivated areas. These species provide the majority of wildlife-related recreational opportunities in the county. Wetland wildlife habitat in the area supports ducks, geese, herons, cormorants, pelicans, egrets, curlews, avocets, terns, and gulls and many smaller birds. Beaver, muskrat, and mink also are common in wetland areas. Cropland and associated areas provide important habitat elements for white-tailed deer, pheasants, and gray partridge. Common predators in the area include fox, badger, coyote, and raccoon. The populations of mule deer, antelope, and sharptailed grouse are small and are limited to areas with expanses of grassland large enough to satisfy the needs of these species.

Although woody cover is not abundant in the survey area, it provides essential food and cover for many wildlife species. Woody habitat is available mostly along the James River and other stream corridors. Farmstead and field windbreaks also provide woody habitat. The James River corridor is a major migration route through the prairie for a large number of bird species, including waterfowl, hawks, and songbirds. The James River and a number of reservoirs and small streams in Brown County support an adequate quantity of fish for recreational purposes.

Because of similarities in topography, in the ability to support distinct plant communities, and in management needs, soil associations provide some indication of the actual and potential distribution and density of wildlife and their habitat. The 18 soil associations in Brown County are described under the heading "General Soil Map Units."

The potential for habitat for white-tailed deer, pheasant, and gray partridge is good in all of the cropland areas in the county. The potential for the development of habitat for pheasant is especially good in the Harmony-Aberdeen-Nahon, Aberdeen-Exline-Harriet, and Williams-Bowbells associations. The Ludden-Lamoure association and the Ludden, ponded, association have the highest potential for the development of habitat for waterfowl. Individual soils in other associations also have potential for the development of wetland wildlife habitat.

Individual soils have different potentials for the development and maintenance of wildlife habitat elements. In table 10, the soils of Brown County are rated according to their potential for providing specific elements of wildlife habitat. 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 the habitat elements; and in determining the intensity of management needed for each habitat element.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element 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 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. The element can be established, 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 are very severe and that unsatisfactory results can be expected. Establishing, improving, or maintaining the element is impractical or impossible.

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

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

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth

of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are intermediate wheatgrass, pubescent wheatgrass, and alfalfa.

Native herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of these plants are big bluestem, goldenrod, beggarweed, western wheatgrass, and green needlegrass.

Planted woody plants include trees and shrubs that require cultivation before and during establishment. They can provide fruit, buds, twigs, bark, and foliage. Soil properties that affect the growth of these plants are depth of the root zone, available water capacity, salinity, and wetness. Examples of these plants are green ash, Russian olive, plum, chokecherry, Rocky Mountain juniper, and eastern redcedar.

Native coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are cedar and juniper.

Native shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of these plants are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are sumac, willow, and snowberry.

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, saltgrass, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

Native deciduous trees and woody understory produce nuts or other fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are elm, cottonwood, ash, willow, plum, and chokecherry.

Information concerning the habitat elements needed to maintain and manage specific wildlife species can be obtained from the local office of the Soil Conservation Service or from the South Dakota Department of Game, Fish and Parks.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations 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 kinds of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the

potential of areas for residential, commercial, industrial, and recreation uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the "Glossary."

Building Site Development

Table 11 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, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, 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. The 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 12 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 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil

properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to 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 12 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 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to wind erosion.

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 13 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 depth to the water table is less than 1 foot. These soils may have layers of suitable material, but the material is less than 3 feet thick.

Sand and *gravel* are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 13, 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 as much as 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 14 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 in the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to 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 wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

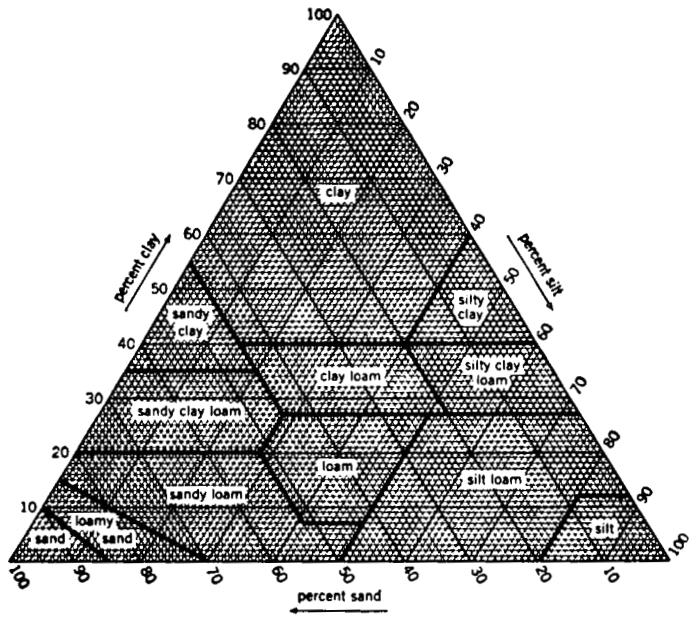

Figure 11.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 11). "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.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

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 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated content of clay in each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at ⅓ bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at

saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion. 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 wind erosion 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 wind erosion 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 wind erosion 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 wind erosion 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 wind erosion 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 wind erosion 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 wind erosion are used.
8. Soils that are not subject to wind erosion because of coarse fragments on the surface or because of surface wetness.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 17 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 17, 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 the 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 17 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; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are

the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion also is expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(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 cool temperature regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic 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 coarse-loamy, mixed Typic 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 underlying material 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" *(10)*. Many of the technical terms used in the descriptions are defined in "Soil Taxonomy" *(12)*. Unless otherwise stated, matrix colors in the descriptions are for dry 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."

Aastad Series

The Aastad series consists of deep, moderately well drained soils formed in loamy glacial till on till plains. Permeability is moderately slow. Slopes range from 0 to 2 percent.

Typical pedon of Aastad loam, in an area of Forman-Aastad loams, 0 to 3 percent slopes; 720 feet north and 550 feet west of the southeast corner of sec. 15, T. 121 N., R. 60 W.

Ap—0 to 6 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, very friable; slightly acid; abrupt smooth boundary.

A—6 to 12 inches; dark gray (10YR 4/1) loam, very dark gray (10YR 3/1) moist; weak coarse and medium subangular blocky structure parting to weak fine granular; slightly hard, very friable; slightly acid; clear wavy boundary.

Bw1—12 to 17 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable; neutral; clear wavy boundary.

Bw2—17 to 24 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable; shiny films on faces of peds; neutral; clear wavy boundary.

Bw3—24 to 28 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable; neutral; gradual wavy boundary.

Bk1—28 to 35 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; few fine distinct light yellowish brown (10YR 6/4) mottles; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable; few fine accumulations of carbonate; strong effervescence; mildly alkaline; gradual wavy boundary.

Bk2—35 to 45 inches; light yellowish brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) moist; many medium and fine distinct gray (10YR 6/1) and light yellowish brown (10YR 6/4) mottles; weak medium prismatic structure parting to weak medium subangular blocky; hard, firm; common medium and fine dark stains (manganese oxide); common medium accumulations of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

C—45 to 60 inches; light yellowish brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) moist; common medium and fine distinct gray (10YR 5/1) and light yellowish brown (10YR 6/4) mottles; massive; hard, firm; common medium and fine strong brown (7.5YR 5/6) iron stains; few fine accumulations of carbonate; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 24 inches. The depth to free carbonates ranges from 18 to 40 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is clay loam or loam. The B horizon has hue of 10YR or 2.5Y, value of 4 to 6 (2 to 4 moist), and chroma of 2 to 4. The C horizon has hue of 2.5Y or 5Y, value of 6 to 8 (4 to 6 moist), and chroma of 2 to 4. It is clay loam or loam.

Aberdeen Series

The Aberdeen series consists of deep, moderately well drained soils formed in clayey glaciolacustrine sediments on glacial lake plains. Permeability is slow in the subsoil and moderate to slow in the underlying material. Slopes range from 0 to 2 percent.

Typical pedon of Aberdeen silty clay loam (fig. 12), in an area of Aberdeen-Nahon silty clay loams; 580 feet west and 93 feet south of the northeast corner of sec. 9, T. 122 N., R. 63 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.

BE—8 to 11 inches; gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; gray (10YR 6/1) silt coatings on faces of peds; weak medium subangular blocky structure parting to weak thin platy; slightly hard, friable; neutral; clear smooth boundary.

Bt1—11 to 18 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; moderate medium prismatic structure parting to moderate fine blocky; hard, firm, sticky and plastic; shiny films on faces of peds; neutral; clear wavy boundary.

Bt2—18 to 26 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; moderate medium prismatic structure parting to moderate medium and fine blocky; hard, firm, sticky and plastic; shiny films on faces of peds; neutral; clear wavy boundary.

Bkz1—26 to 31 inches; light gray (2.5Y 7/2) silty clay loam, grayish brown (2.5Y 5/2) moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, firm, sticky and plastic; common very fine accumulations of carbonate; common fine nests of gypsum and other salts; strong effervescence; mildly alkaline; clear wavy boundary.

Bkz2—31 to 38 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist;

weak medium prismatic structure parting to weak medium subangular blocky; hard, firm, sticky and plastic; common very fine accumulations of carbonate; common fine nests of gypsum and other salts; strong effervescence; mildly alkaline; gradual wavy boundary.

Figure 12.—Profile of an Aberdeen silty clay loam. The sodium-affected subsoil is at a depth of about 11 inches. Depth is marked in feet.

C1—38 to 51 inches; light gray (2.5Y 7/2) silt loam, grayish brown (2.5Y 5/2) moist; few fine distinct yellowish brown (10YR 5/6) and gray (10YR 5/1) mottles; massive; hard, friable; few fine threads and nests of gypsum and other salts; slight effervescence; mildly alkaline; gradual wavy boundary.

C2—51 to 60 inches; pale yellow (2.5Y 7/4) silt loam that has varves of silty clay and very fine sandy loam 1 to 3 millimeters thick; light olive brown (2.5Y 5/4) moist; common fine distinct yellowish brown (10YR 5/6), strong brown (7.5YR 5/6), and gray (10YR 5/1) mottles; massive; slightly hard, friable; slight effervescence; mildly alkaline.

The surface soil is 7 to 16 inches thick. The depth to free carbonates ranges from 16 to 32 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is silt loam or silty clay loam. Some pedons have an E or B/E horizon. The Bt horizon has hue of 10YR or 2.5Y, value of 3 to 5 (2 or 3 moist), and chroma of 1 to 3. It is silty clay loam, silty clay, or clay. Some pedons have a Btk horizon. The C horizon has hue of 2.5Y or 5Y, value of 5 to 8 (4 to 6 moist), and chroma of 2 to 4. It is silt loam or silty clay loam and typically is varved with very fine sand to clay in the lower part. The varves range from less than 1 millimeter to 10 millimeters in thickness. Some pedons have fine sand below a depth of 40 inches.

Arveson Series

The Arveson series consists of deep, poorly drained and very poorly drained soils formed in calcareous, sandy glaciolacustrine sediments on glacial lake plains. Permeability is moderate or moderately rapid in the subsoil and moderately rapid or rapid in the underlying material. Slopes are less than 2 percent.

Typical pedon of Arveson fine sandy loam, 1,250 feet east and 150 feet north of the southwest corner of sec. 16, T. 126 N., R. 61 W.

A—0 to 9 inches; gray (10YR 5/1) fine sandy loam, very dark gray (10YR 3/1) moist; weak fine subangular blocky structure parting to weak fine granular; slightly hard, very friable; many fine and very fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

Bk—9 to 17 inches; gray (5Y 6/1) fine sandy loam, dark olive gray (5Y 3/2) moist; weak medium subangular blocky structure; slightly hard, friable; common fine and very fine roots; violent effervescence; moderately alkaline; gradual wavy boundary.

Bkg—17 to 24 inches; light gray (5Y 7/1) fine sandy

loam, olive gray (5Y 5/2) moist; weak medium subangular blocky structure; slightly hard, friable; few very fine roots; violent effervescence; moderately alkaline; gradual wavy boundary.

Cg1—24 to 36 inches; light gray (5Y 7/2) loamy fine sand, olive gray (5Y 5/2) moist; few fine distinct yellowish brown (10YR 5/6) mottles; massive; slightly hard, very friable; slight effervescence; moderately alkaline; gradual wavy boundary.

Cg2—36 to 60 inches; light gray (5Y 7/2) loamy fine sand, olive gray (5Y 5/2) moist; many medium and fine distinct yellowish brown (10YR 5/6) and gray (10YR 6/1) mottles; massive; slightly hard, very friable; common medium and fine dark stains (manganese oxide); slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 24 inches. The calcium carbonate equivalent ranges from 15 to 40 percent within a depth of 16 inches.

The A horizon has hue of 10YR, 2.5Y, or 5Y and value of 4 to 6 (2 or 3 moist). It is loam, silt loam, fine sandy loam, or sandy loam. The Bk horizon has hue of 2.5Y or 5Y or is neutral in hue. It has value of 5 to 7 (3 to 5 moist) and chroma of 0 to 2. It is sandy loam, fine sandy loam, or loam. The Cg horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 1 or 2. It is sand, fine sand, loamy sand, loamy fine sand, sandy loam, or fine sandy loam.

Barnes Series

The Barnes series consists of deep, well drained soils formed in loamy glacial till on till plains and moraines. Permeability is moderate in the subsoil and moderately slow in the underlying material. Slopes range from 0 to 15 percent.

Typical pedon of Barnes loam (fig. 13), in an area of Barnes-Svea loams, 1 to 6 percent slopes; 2,586 feet west and 219 feet south of the northeast corner of sec. 16, T. 128 N., R. 63 W.

Figure 13.—Profile of a Barnes loam. Calcium carbonate is at a depth of 18 inches. Depth is marked in feet.

Ap—0 to 7 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, friable; many fine and very fine roots; medium acid; abrupt smooth boundary.

Bw1—7 to 13 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; slightly hard, friable; thin discontinuous shiny films on vertical faces of peds; slightly acid; clear wavy boundary.

Bw2—13 to 18 inches; pale brown (10YR 6/3) loam, dark brown (10YR 4/3) moist; weak coarse prismatic structure parting to moderate coarse and medium subangular blocky; slightly hard, friable; thin discontinuous shiny films on vertical faces of peds; neutral; clear wavy boundary.

Bk—18 to 40 inches; light brownish gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; weak coarse and medium subangular blocky structure; hard, friable; many medium and fine accumulations of

carbonate; strong effervescence; mildly alkaline; gradual wavy boundary.

C—40 to 60 inches; light brownish gray (2.5Y 6/2) loam, light olive brown (2.5Y 5/4) moist; few fine distinct yellowish brown (10YR 5/6) mottles; slightly hard, friable; common fine accumulations of carbonate; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The depth to free carbonates ranges from 10 to 23 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is loam, silt loam, or fine sandy loam. The Bw horizon has hue of 10YR or 2.5Y, value of 4 to 6 (2 to 5 moist), and chroma of 2 or 3. It is loam, clay loam, or sandy clay loam. The C horizon has value of 5 to 7 (4 to 6 moist) and chroma of 2 to 4. It is loam or clay loam.

Bearden Series

The Bearden series consists of deep, somewhat poorly drained soils formed in silty glaciolacustrine sediments on glacial lake plains. Permeability is moderate to slow. Slopes range from 0 to 2 percent.

Typical pedon of Bearden silt loam, 890 feet north and 80 feet west of the southeast corner of sec. 10, T. 127 N., R. 60 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak medium and fine subangular blocky structure parting to weak fine and very fine granular; slightly hard, friable; common very fine roots; strong effervescence; mildly alkaline; abrupt smooth boundary.

ABk—8 to 12 inches; gray (10YR 5/1) silt loam, dark gray (10YR 4/1) moist; weak medium and fine subangular blocky structure parting to weak fine and very fine granular; slightly hard, friable; common very fine roots; common medium and fine accumulations of carbonate; strong effervescence; mildly alkaline; clear wavy boundary.

Bk—12 to 26 inches; light gray (5Y 7/1) silt loam, olive gray (5Y 5/2) moist; weak coarse subangular blocky structure parting to weak medium subangular blocky; hard, friable, sticky and plastic; few very fine roots; violent effervescence; mildly alkaline; gradual wavy boundary.

Bkz—26 to 39 inches; light gray (5Y 7/2) silt loam, olive (5Y 5/3) moist; common fine prominent strong brown (7.5YR 5/6) mottles; weak coarse subangular blocky structure parting to weak medium subangular blocky; slightly hard, friable; many fine nests and crystals of salt; violent effervescence; moderately alkaline; gradual wavy boundary.

C—39 to 60 inches; pale yellow (2.5Y 7/4) silt loam, light olive brown (2.5Y 5/4) moist; many medium distinct yellowish brown (10YR 5/6) mottles; massive; soft, very friable; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 20 inches thick. The soils have free carbonates throughout.

The A horizon has hue of 10YR or 2.5Y and value of 4 or 5 (2 or 3 moist). It is silt loam or silty clay loam. Some pedons do not have an ABk horizon. The Bk horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 7 (3 to 5 moist), and chroma of 1 to 4. It is silt loam or silty clay loam. The C horizon has value of 5 to 7 (4 to 6 moist) and chroma of 2 to 4. It is silt loam or silty clay loam. Some pedons are varved with silt, very fine sand, or silty clay below a depth of 40 inches.

Beotia Series

The Beotia series consists of deep, well drained and moderately well drained soils formed in silty glaciolacustrine sediments on glacial lake plains. Permeability is moderate in the subsoil and moderate to slow in the underlying material. Slopes range from 0 to 6 percent.

Typical pedon of Beotia silt loam, 0 to 2 percent slopes, 2,370 feet north and 125 feet east of the southwest corner of sec. 18, T. 123 N., R. 61 W.

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

A—7 to 11 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak fine granular; slightly hard, friable; common fine roots; neutral; clear smooth boundary.

Bw1—11 to 16 inches; grayish brown (10YR 5/2) silty clay loam, very dark gray (10YR 3/1) moist; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable; common fine roots; neutral; clear smooth boundary.

Bw2—16 to 20 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable; common fine roots; neutral; abrupt wavy boundary.

Bk1—20 to 32 inches; pale yellow (2.5Y 7/4) silt loam, light olive brown (2.5Y 5/4) moist; weak coarse prismatic structure; slightly hard, friable; few fine roots; common fine pores; few fine accumulations of carbonate; violent effervescence; moderately

alkaline; gradual smooth boundary.

Bk2—32 to 42 inches; pale yellow (2.5Y 8/4) silt loam, light olive brown (2.5Y 5/4) moist; weak very coarse prismatic structure; slightly hard, friable; few fine roots; many fine pores; few fine accumulations of carbonate; few fine nests of gypsum and other salts; violent effervescence; moderately alkaline; clear smooth boundary.

C—42 to 60 inches; pale yellow (2.5Y 8/4) silt loam that has varves of silty clay and very fine sandy loam; light olive brown (2.5Y 5/4) moist; common fine distinct yellowish brown (10YR 5/6), strong brown (7.5YR 5/6), and gray (10YR 6/1) mottles; massive; slightly hard, friable; few fine pores; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon and the depth to free carbonates range from 16 to 30 inches. The A horizon has value of 3 or 4 (2 or 3 moist). The Bw horizon has hue of 10YR or 2.5Y, value of 4 to 6 (2 to 4 moist), and chroma of 1 to 3. The C horizon has value of 6 to 8 (4 to 6 moist) and chroma of 2 to 4. It is silt loam or silty clay loam and is varved with very fine sand to clay in the lower part. The varves range from less than 1 millimeter to 10 millimeters in thickness.

Borup Series

The Borup series consists of deep, poorly drained soils formed in calcareous glaciolacustrine sediments on glacial lake plains. Permeability is moderately rapid. Slopes range from 0 to 2 percent.

Typical pedon of Borup silt loam, 1,200 feet north and 245 feet west of the southeast corner of sec. 36, T. 126 N., R. 61 W.

A—0 to 8 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak fine granular structure; soft, very friable; many fine and very fine roots; strong effervescence; moderately alkaline; clear wavy boundary.

Ak—8 to 16 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak medium and fine subangular blocky structure parting to weak fine granular; soft, very friable; common very fine roots; fine accumulations of carbonate; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk—16 to 27 inches; gray (10YR 5/1) very fine sandy loam, dark gray (10YR 4/1) moist; weak medium and fine subangular blocky structure; slightly hard, very friable; fine accumulations of carbonate; violent effervescence; moderately alkaline; gradual wavy boundary.

Bkg—27 to 46 inches; light gray (5Y 7/1) loamy very fine sand, olive gray (5Y 5/2) moist; weak medium subangular blocky structure; hard, very friable; few fine accumulations of carbonate; violent effervescence; moderately alkaline; gradual wavy boundary.

Cg—46 to 60 inches; light gray (5Y 7/2) loamy very fine sand, olive gray (5Y 5/2) moist; many fine distinct yellowish brown (10YR 5/6) mottles; massive; hard, very friable; few fine dark stains (manganese oxide); few fine accumulations of carbonate; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 20 inches. The A horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 4 or 5 (2 or 3 moist). It is very fine sandy loam, silt loam, loam, silty clay loam, or sandy clay loam. The Bk horizon has hue of 10YR, 2.5Y, or 5Y and value of 5 to 7 (4 to 6 moist). It is loam, silt loam, very fine sandy loam, loamy very fine sand, or sandy clay loam. The Cg horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 5 to 7 (4 to 6 moist) and chroma of 0 to 3. It is very fine sand, loamy very fine sand, very fine sandy loam, loam, or silt loam.

Bowbells Series

The Bowbells series consists of deep, moderately well drained soils formed in loamy glacial till and local alluvium derived from glacial till. These soils are on till plains. Permeability is moderate in the subsoil and moderately slow in the underlying material. Slopes range from 0 to 3 percent.

The Bowbells soils in this county have lower chroma in the A horizon than is definitive for the series. This difference, however, does not alter the use or behavior of the soils.

Typical pedon of Bowbells loam, in an area of Williams-Bowbells loams, 0 to 3 percent slopes; 550 feet east and 25 feet south of the northwest corner of sec. 25, T. 121 N., R. 65 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, friable; many fine roots; slightly acid; abrupt smooth boundary.

A—7 to 13 inches; dark grayish brown (10YR 4/2) loam, black (10YR 2/1) moist; weak coarse and medium subangular blocky structure parting to weak fine granular; slightly hard, friable; many very fine roots; neutral; clear wavy boundary.

Bt1—13 to 22 inches; brown (10YR 5/3) clay loam, very dark grayish brown (10YR 3/2) moist; moderate

medium prismatic structure parting to moderate coarse and medium subangular blocky; hard, friable; few very fine roots; discontinuous shiny films on faces of peds; neutral; clear wavy boundary.

Bt2—22 to 33 inches; pale brown (10YR 6/3) clay loam, dark brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate coarse and medium subangular blocky; hard, friable; few very fine roots; discontinuous shiny films on faces of peds; neutral; clear wavy boundary.

Bk—33 to 48 inches; light gray (2.5Y 7/2) clay loam, light olive brown (2.5Y 5/4) moist; common fine faint yellowish brown (10YR 5/6) mottles; weak coarse and medium subangular blocky structure; hard, friable; common fine accumulations of carbonate; strong effervescence; moderately alkaline; clear wavy boundary.

C—48 to 60 inches; light gray (2.5Y 7/2) clay loam, grayish brown (2.5Y 5/2) moist; many fine distinct yellowish brown (10YR 5/6), common fine distinct gray (10YR 6/1), and few fine prominent yellowish red (5YR 4/6) mottles; massive; hard, friable; common medium and many fine accumulations of carbonate; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 25 inches. The depth to free carbonates ranges from 22 to 36 inches.

The A horizon has value of 4 or 5 (2 or 3 moist). It is loam, silt loam, or clay loam. The Bt horizon has hue of 10YR or 2.5Y and value of 4 to 6 (2 to 4 moist). It is clay loam or loam. The C horizon has value of 4 to 7 (3 to 5 moist) and chroma of 2 to 4. It is loam or clay loam.

Brantford Variant

The Brantford Variant consists of deep, well drained soils formed in outwash sediments that are shallow over shaly and sandy sediments. These soils are on outwash plains and terraces. Permeability is moderate in the subsoil and rapid or very rapid in the underlying material. Slopes range from 0 to 6 percent.

Typical pedon of Brantford Variant loam, in an area of Brantford Variant-Vang loams, 2 to 6 percent slopes; 2,218 feet east and 94 feet south of the northwest corner of sec. 36, T. 126 N., R. 65 W.

A1—0 to 3 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak fine granular; soft, very friable; many fine and very fine roots; slightly acid; clear smooth boundary.

A2—3 to 7 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable; many fine roots; slightly acid; clear smooth boundary.

Bw—7 to 15 inches; brown (10YR 5/3) clay loam, very dark grayish brown (10YR 3/2) moist; moderate coarse and medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable; common fine roots along faces of peds; slightly acid; abrupt smooth boundary.

2C1—15 to 28 inches; grayish brown (2.5Y 5/2) very gravelly clay loam, very dark grayish brown (2.5Y 3/2) moist; single grain; loose; about 45 percent shale fragments and granitic pebbles; slight effervescence; mildly alkaline; gradual smooth boundary.

2C2—28 to 40 inches; light brownish gray (2.5Y 6/2) very gravelly loam, dark grayish brown (2.5Y 4/2) moist; single grain; loose; about 35 percent shale fragments; strong effervescence; mildly alkaline; abrupt smooth boundary.

2C3—40 to 60 inches; brown (10YR 5/3) very gravelly coarse sand, very dark grayish brown (10YR 3/2) moist; single grain; loose; about 15 percent shale fragments; slight effervescence; moderately alkaline.

The mollic epipedon ranges from 7 to 16 inches in thickness. The depth to shaly and sandy sediments ranges from 10 to 20 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). The Bw horizon has hue of 10YR or 2.5Y, value of 4 or 5 (3 or 4 moist), and chroma of 1 to 3. It is loam or clay loam. It averages as low as 20 percent clay in some pedons and as high as 30 percent clay in others. The 2C horizon is gravelly loam, very gravelly loam, or very gravelly clay loam in the upper part and very gravelly coarse sand, gravelly coarse sand, or gravelly sand in the lower part. The content of shale fragments in this horizon commonly is 15 percent or more, by volume.

Brookings Series

The Brookings series consists of deep, moderately well drained soils formed in silty material over glacial till. These soils are on till plains. Permeability is moderate in the silty material and moderately slow in the underlying glacial till. Slopes range from 0 to 2 percent.

Typical pedon of Brookings silt loam, in an area of Kranzburg-Brookings-Buse complex, 1 to 6 percent

slopes; 1,700 feet west and 150 feet south of the northeast corner of sec. 11, T. 121 N., R. 60 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak fine granular structure; hard, friable; medium acid; abrupt smooth boundary.

A—8 to 14 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak medium subangular blocky structure; hard, friable; slightly acid; clear wavy boundary.

Bw1—14 to 21 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak coarse and medium prismatic structure parting to weak medium subangular blocky; hard, friable; neutral; gradual wavy boundary.

Bw2—21 to 27 inches; light olive brown (2.5Y 5/4) silt loam, olive brown (2.5Y 4/4) moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable; moderately alkaline; gradual wavy boundary.

Bk1—27 to 30 inches; light yellowish brown (2.5Y 6/4) silt loam, olive brown (2.5Y 4/4) moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable; few fine accumulations of carbonate; strong effervescence; moderately alkaline; abrupt smooth boundary.

2Bk2—30 to 38 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; common fine faint brownish yellow (10YR 6/6) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, firm; few fine concretions of manganese oxide; common medium and fine accumulations of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

2C—38 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, olive brown (2.5Y 4/4) moist; common fine faint brownish yellow (10YR 6/6) mottles; massive; hard, firm; few medium and fine strong brown (7.5YR 5/6) iron stains; many fine accumulations of carbonate; slight effervescence; moderately alkaline.

The depth to free carbonates ranges from 20 to 36 inches. The depth to glacial till ranges from 20 to 40 inches. The thickness of the mollic epipedon ranges from 16 to 25 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is silt loam or silty clay loam. The Bw horizon has value of 3 to 5 (2 to 4 moist) and chroma of 1 to 4. It is silt loam or silty clay loam. The 2C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 or 5 moist), and chroma of 2 to 4. It is clay loam or loam.

Buse Series

The Buse series consists of deep, well drained soils formed in loamy glacial till on till plains and moraines. Permeability is moderately slow. Slopes range from 3 to 25 percent.

Typical pedon of Buse loam, in an area of Barnes-Buse loams, 6 to 15 percent slopes; 1,850 feet west and 140 feet north of the southeast corner of sec. 18, T. 128 N., R. 63 W.

A—0 to 7 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak fine granular; slightly hard, friable; few fine accumulations of carbonate; strong effervescence; mildly alkaline; clear smooth boundary.

Bk—7 to 22 inches; pale brown (10YR 6/3) loam, dark brown (10YR 4/3) moist; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable; common large and medium accumulations of carbonate; violent effervescence; mildly alkaline; gradual wavy boundary.

C—22 to 60 inches; light yellowish brown (2.5Y 6/4) loam, olive brown (2.5Y 4/4) moist; massive; slightly hard, friable; few large and medium accumulations of carbonate; strong effervescence; mildly alkaline.

The mollic epipedon ranges from 7 to 10 inches in thickness. Typically, free carbonates are at the surface, but in some pedons the A horizon is partially or completely free of carbonates.

The A horizon has value of 3 to 5 (2 or 3 moist). It is loam or clay loam. The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 7 (4 to 6 moist), and chroma of 2 to 4. It is loam or clay loam. The C horizon has hue of 10YR or 2.5Y, value of 4 to 7 (4 to 6 moist), and chroma of 2 to 4. It is loam or clay loam.

Camtown Series

The Camtown series consists of deep, moderately well drained and somewhat poorly drained soils formed in glaciolacustrine sediments on glacial lake plains. Permeability is moderately slow or slow in the subsoil and moderate to slow in the underlying material. Slopes range from 0 to 2 percent.

Typical pedon of Camtown loam, in an area of Camtown-Turton loams; 2,015 feet east and 225 feet south of the northwest corner of sec. 16, T. 123 N., R. 63 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) loam, black

(10YR 2/1) moist; weak medium subangular blocky structure; soft, friable; common fine and very fine roots; medium acid; abrupt smooth boundary.

A—7 to 10 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak fine granular; slightly hard, friable; common fine and very fine roots; medium acid; clear wavy boundary.

BE—10 to 13 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; light brownish gray (10YR 6/2) silt coatings on faces of peds; weak medium prismatic structure parting to moderate coarse and medium subangular blocky; hard, friable; common fine and very fine roots; medium acid; clear wavy boundary.

Bt1—13 to 17 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate coarse and medium subangular blocky; hard, friable; few very fine roots; light brownish gray (10YR 6/2) coatings extending 1 to 2 inches along vertical faces of peds; thin discontinuous films on vertical faces of peds; slightly acid; clear wavy boundary.

Bt2—17 to 25 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; moderate coarse and medium prismatic structure parting to moderate coarse and medium subangular blocky; hard, friable; few very fine roots; thin discontinuous films on vertical faces of peds; slightly acid; clear wavy boundary.

Bk—25 to 37 inches; light gray (2.5Y 7/2) loam, light brownish gray (2.5Y 6/2) moist; weak coarse and medium subangular blocky structure; slightly hard, friable; few very fine roots; many medium and fine accumulations of carbonate; few fine nests of salt; strong effervescence; moderately alkaline; gradual wavy boundary.

C—37 to 60 inches; light gray (2.5Y 7/2) loam, light brownish gray (2.5Y 6/2) moist; common fine distinct yellowish brown (10YR 5/6) mottles; massive; soft, friable; strong effervescence; moderately alkaline.

The surface soil is 6 to 20 inches thick. The depth to free carbonates ranges from 16 to 38 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is loam, fine sandy loam, or very fine sandy loam. The Bt horizon has hue of 10YR or 2.5Y, value of 3 to 5 (3 or 4 moist), and chroma of 1 to 4. It is loam, silty clay loam, or clay loam. The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is silt loam, loam, or very fine sandy loam.

Cavour Series

The Cavour series consists of deep, moderately well drained soils formed in loamy and clayey glacial till on till plains. Permeability is slow or very slow in the subsoil and moderately slow or slow in the underlying material. Slopes range from 0 to 6 percent.

Typical pedon of Cavour loam, in an area of Williams-Cavour loams, 3 to 6 percent slopes; 1,308 feet south and 64 feet east of the northwest corner of sec. 28, T. 123 N., R. 64 W.

Ap—0 to 6 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium and fine granular structure; slightly hard, very friable; many fine and very fine roots; neutral; abrupt smooth boundary.

A—6 to 8 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium and fine granular structure; slightly hard, very friable; common fine and very fine roots; neutral; abrupt smooth boundary.

E—8 to 10 inches; gray (10YR 5/1 and 6/1) loam, very dark gray (10YR 3/1) moist; moderate thin and very thin platy structure; slightly hard, very friable; common fine and very fine roots; neutral; abrupt smooth boundary.

Bt1—10 to 15 inches; dark grayish brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate coarse and medium columnar structure parting to strong medium and fine blocky; very hard, firm, sticky and plastic; few very fine roots; thin continuous gray (10YR 6/1) coatings on the top of columns; continuous shiny films on vertical faces of peds; moderately alkaline; clear smooth boundary.

Bt2—15 to 22 inches; dark grayish brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate coarse and medium prismatic structure parting to moderate medium and fine blocky; very hard, firm, sticky and plastic; continuous shiny films on vertical faces of peds; moderately alkaline; gradual wavy boundary.

Btkz—22 to 27 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; moderate medium prismatic structure parting to moderate medium and fine blocky; very hard, firm, sticky and plastic; discontinuous shiny films on vertical faces of peds; common medium and fine accumulations of carbonate; common fine nests of salt; slight effervescence; moderately alkaline; clear wavy boundary.

C1—27 to 36 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; massive; hard, friable; few fine nests of salt; strong

effervescence; strongly alkaline; gradual wavy boundary.

C2—36 to 60 inches; light gray (2.5Y 7/2) clay loam, grayish brown (2.5Y 5/2) moist; common fine distinct yellowish brown (10YR 5/6) and gray (5Y 5/1) mottles; massive; hard, friable; few fine dark stains (manganese oxide); few fine strong brown (7.5YR 5/6) iron stains; few fine nests of salt; strong effervescence; strongly alkaline.

The surface soil is 5 to 14 inches thick. The thickness of the mollic epipedon ranges from 7 to 35 inches. The depth to free carbonates ranges from 14 to 35 inches. The depth to accumulations of gypsum and other salts ranges from 16 to 45 inches.

The A horizon has value of 3 to 5 (2 or 3 moist). It is loam or silt loam. The E horizon has value of 5 to 7 (3 to 5 moist) and chroma of 1 or 2. It is silt loam or loam. The Bt horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 5 (2 to 4 moist), and chroma of 1 or 2. It is silty clay, clay loam, or clay. The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 or 5 moist), and chroma of 2 to 4. It is clay loam or loam.

Colvin Series

The Colvin series consists of deep, poorly drained and very poorly drained soils formed in silty glaciolacustrine sediments on glacial lake plains. Permeability is moderate or moderately rapid in the upper part of the profile and moderate to slow in the lower part. Slopes are less than 1 percent.

Typical pedon of Colvin silty clay loam, 650 feet south and 625 feet west of the northeast corner of sec. 6, T. 127 N., R. 60 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; moderate medium and fine granular structure; slightly hard, friable; many fine and very fine roots; strong effervescence; moderately alkaline; abrupt smooth boundary.

Bk—8 to 19 inches; light gray (5Y 7/2) silt loam, light olive gray (5Y 6/2) moist; weak coarse and medium subangular blocky structure; hard, friable; common very fine roots; few fine nests of salt; few crystals of gypsum; violent effervescence; moderately alkaline; clear wavy boundary.

Cg1—19 to 30 inches; light gray (5Y 7/2) silty clay loam, olive gray (5Y 5/2) moist; many fine distinct yellowish brown (10YR 5/8) mottles; massive; hard, friable; few very fine roots; many crystals of gypsum; strong effervescence; moderately alkaline; clear wavy boundary.

Cg2—30 to 48 inches; light gray (5Y 7/2) silt loam, olive gray (5Y 5/2) moist; many coarse and medium distinct yellowish brown (10YR 5/8) mottles; massive; hard, friable; few very fine roots to a depth of 40 inches; few fine distinct strong brown (7.5YR 5/6) iron stains; few crystals of gypsum; strong effervescence; strongly alkaline; clear wavy boundary.

Cg3—48 to 60 inches; pale olive (5Y 6/3) silt loam, olive (5Y 5/3) moist; many coarse distinct yellowish brown (10YR 5/8) mottles; massive; hard, friable; varved; few crystals of gypsum; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 24 inches thick. The A horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 3 or 4 (2 or 3 moist). It is silt loam, silty clay loam, or silty clay. The Bk horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 5 to 8 (3 to 6 moist) 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 5 to 7 (3 to 6 moist), and chroma of 1 to 4. Some pedons have sand, loam, clay loam, or clay below a depth of 40 inches.

Cresbard Series

The Cresbard series consists of deep, moderately well drained soils formed in loamy glacial till on till plains. Permeability is slow or moderately slow. Slopes range from 0 to 6 percent.

Typical pedon of Cresbard silt loam, in an area of Barnes-Cresbard-Tonka complex, 0 to 6 percent slopes; 360 feet south and 165 feet east of the northwest corner of sec. 31, T. 124 N., R. 64 W.

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

E—7 to 10 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak thick platy structure; slightly hard, very friable; common very fine roots; slightly acid; clear wavy boundary.

BE—10 to 16 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; gray (10YR 5/1) silt coatings on faces of peds; moderate medium and fine blocky structure; hard, friable; common very fine roots; slightly acid; clear wavy boundary.

Bt1—16 to 24 inches; grayish brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to strong medium and fine blocky; very hard, firm,

sticky and plastic; few very fine roots; continuous shiny films on vertical faces of peds; slightly acid; clear wavy boundary.

Bt2—24 to 30 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to strong medium and fine blocky; very hard, firm, sticky and plastic; few very fine roots; continuous shiny films on vertical faces of peds; neutral; clear wavy boundary.

Bk—30 to 45 inches; light yellowish brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) moist; common fine distinct yellowish brown (10YR 5/6) and gray (10YR 5/1) mottles; weak coarse subangular blocky structure; hard, firm; many fine accumulations of carbonate; few fine nests of salt; strong effervescence; moderately alkaline; gradual wavy boundary.

C—45 to 60 inches; light yellowish brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) moist; many medium and fine distinct gray (10YR 5/1) and yellowish brown (10YR 5/6) mottles; massive; hard, firm; common fine accumulations of carbonate; strong effervescence; moderately alkaline.

The surface soil is 7 to 17 inches thick. The depth to free carbonates ranges from 15 to 40 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is loam or silt loam. The E horizon has value of 5 or 6 (3 or 4 moist) and chroma of 1 or 2. It is loam or silt loam. Some pedons do not have an E horizon. The Bt horizon has value of 3 to 6 (2 to 4 moist) and chroma of 1 to 3. It is silty clay, clay loam, or clay. The C horizon has value of 5 to 7 (4 to 6 moist) and chroma of 2 to 4. It is loam or clay loam.

Daglum Series

The Daglum series consists of deep, moderately well drained soils formed in clayey alluvium on terraces. Permeability is very slow. Slopes range from 0 to 4 percent.

Typical pedon of Daglum loam, in an area of Daglum-Rhoades loams, 0 to 4 percent slopes; 1,055 feet west and 100 feet north of the southeast corner of sec. 18, T. 124 N., R. 65 W.

A—0 to 6 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, very friable; many very fine roots; medium acid; clear smooth boundary.

E—6 to 9 inches; light brownish gray (10YR 6/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure parting to weak medium and thin platy; slightly hard, very friable; many very fine roots; medium acid; abrupt smooth boundary.

Bt1—9 to 15 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; strong coarse and medium columnar structure parting to moderate medium and fine angular blocky; very hard, firm, sticky and plastic; many very fine roots along vertical faces of peds; thin continuous gray (10YR 6/1) coatings on the top of columns; slightly acid; clear wavy boundary.

Bt2—15 to 19 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate coarse prismatic structure parting to moderate medium angular blocky; very hard, firm, sticky and plastic; common very fine roots along vertical faces of peds; slightly acid; clear wavy boundary.

Bkz—19 to 25 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; very hard, firm, sticky and plastic; common medium and fine accumulations of carbonate; common fine nests of salt; strong effervescence; moderately alkaline; clear wavy boundary.

Bk—25 to 42 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; very hard, firm, sticky and plastic; common fine and few medium accumulations of carbonate; about 15 percent shale chips; strong effervescence; moderately alkaline; gradual wavy boundary.

Cr—42 to 60 inches; gray (5Y 6/1) bedded shale, very dark gray (5Y 3/1) moist; many fine strong brown (7.5YR 5/6) iron stains on surfaces of plates; few fine accumulations of carbonate in seams; common medium and fine crystals of salt in seams; slight effervescence; mildly alkaline.

The surface soil is 5 to 12 inches thick. The depth to soft shale is more than 40 inches.

The A horizon has value of 4 or 5 (2 or 3 moist). It is clay loam, silty clay loam, silt loam, or loam. The E horizon has hue of 10YR or 2.5Y, value of 4 to 7 (3 to 5 moist), and chroma of 1 or 2. It is very fine sandy loam, loam, silt loam, clay loam, or silty clay loam. The Bt horizon has hue of 10YR or 2.5Y, value of 4 to 6 (3 to 5 moist), and chroma of 2 or 3. It is clay, silty clay, silty clay loam, or clay loam. Some pedons have a C horizon.

Divide Series

The Divide series consists of deep, somewhat poorly drained and moderately well drained soils formed in loamy sediments that are moderately deep over gravelly sand. These soils are on outwash plains. Permeability is moderate in the subsoil and rapid or very rapid in the underlying gravelly sand. Slopes range from 0 to 2 percent.

Typical pedon of Divide loam, in an area of Spottswood-Divide loams, 0 to 2 percent slopes; 1,825 feet west and 240 feet north of the southeast corner of sec. 30, T. 124 N., R. 63 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) loam, very dark gray (10YR 3/1) moist; weak fine granular structure; slightly hard, friable; common medium and fine accumulations of carbonate; strong effervescence; mildly alkaline; abrupt smooth boundary.

ABk—8 to 14 inches; gray (10YR 5/1) loam, dark gray (10YR 4/1) moist; weak coarse subangular blocky structure; slightly hard, friable; many medium and fine accumulations of carbonate; violent effervescence (20 percent calcium carbonate); moderately alkaline; clear wavy boundary.

Bk1—14 to 20 inches; white (10YR 8/1) loam, light brownish gray (2.5Y 6/2) moist; weak coarse subangular blocky structure; slightly hard, friable; violent effervescence (35 percent calcium carbonate); moderately alkaline; gradual wavy boundary.

Bk2—20 to 26 inches; light gray (2.5Y 7/2) loam, grayish brown (2.5Y 5/2) moist; common medium and fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; slightly hard, friable; common coarse accumulations of carbonate; violent effervescence (25 percent calcium carbonate); moderately alkaline; clear wavy boundary.

2C—26 to 60 inches; yellowish brown (10YR 5/4) gravelly sand, dark yellowish brown (10YR 4/4) moist; single grain; loose; slight effervescence; moderately alkaline.

The mollic epipedon ranges from 7 to 20 inches in thickness. The depth to gravelly sand is 20 to 40 inches.

The A horizon has value of 3 to 5 (2 or 3 moist). It is loam, sandy loam, or silt loam. Some pedons do not have an ABk horizon. The Bk horizon has value of 5 to 8 (3 to 6 moist) and chroma of 1 to 4. It is loam or clay loam. The 2C horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 7 (4 or 5 moist), and chroma of 2 to 6.

Dovray Series

The Dovray series consists of deep, poorly drained and very poorly drained soils formed in clayey alluvium or glaciolacustrine sediments. These soils are on flood plains and glacial lake plains. Permeability is slow or very slow. Slopes are 0 to 1 percent.

Typical pedon of Dovray silty clay, 2,040 feet east and 140 feet south of the northwest corner of sec. 6, T. 122 N., R. 63 W.

Ap—0 to 6 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; weak coarse and medium subangular blocky structure parting to moderate fine granular; very hard, firm, sticky and plastic; many roots; slightly acid; abrupt smooth boundary.

A—6 to 16 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; weak coarse subangular blocky structure parting to moderate fine angular blocky; very hard, firm, sticky and plastic; common roots; slightly acid; gradual wavy boundary.

Bg—16 to 24 inches; gray (N 5/0) silty clay, very dark gray (N 3/0) moist; weak coarse subangular blocky structure parting to moderate fine and very fine angular blocky; very hard, firm, sticky and plastic; few roots; neutral; gradual wavy boundary.

Bkg1—24 to 33 inches; gray (N 5/0) silty clay, very dark gray (N 3/0) moist; weak coarse subangular blocky structure parting to weak very fine subangular blocky; very hard, firm, sticky and plastic; few roots; few medium and fine accumulations of carbonate; strong effervescence; neutral; gradual wavy boundary.

Bkg2—33 to 40 inches; light gray (5Y 7/1) silty clay, olive gray (5Y 5/2) moist; many medium and fine distinct light olive brown (2.5Y 5/6) mottles; weak coarse subangular blocky structure; very hard, firm, sticky and plastic; few fine dark stains (manganese oxide); common medium and fine accumulations of carbonate; few shale chips; strong effervescence; neutral; gradual wavy boundary.

Cg—40 to 60 inches; light gray (5Y 7/1) silty clay loam, olive gray (5Y 5/2) moist; many medium and fine distinct light olive brown (2.5Y 5/6) and few medium prominent yellowish brown (10YR 5/8) mottles; massive; very hard, friable; few fine accumulations of carbonate; slight effervescence; neutral.

The mollic epipedon ranges from 24 to 54 inches in thickness. The depth to free carbonates ranges from 20 to 60 inches. Pedons in some uncultivated areas have a 2- to 4-inch O horizon over the A horizon.

The A horizon has value of 3 or 4 (2 or 3 moist). It is clay or silty clay. The B horizon has hue of 2.5Y or 5Y

or is neutral in hue. It has value of 5 to 7 (3 to 6 moist) and chroma of 0 to 2. It is clay or silty clay. The C horizon has hue of 2.5Y or 5Y and value of 5 to 7 (4 to 6 moist). It is silty clay loam, silty clay, clay, or clay loam.

Dovray Variant

The Dovray Variant consists of deep, somewhat poorly drained soils formed in clayey alluvium on flood plains. Permeability is slow or very slow. Slopes are 0 to 1 percent.

Typical pedon of Dovray Variant silty clay, 400 feet west and 175 feet south of the northeast corner of sec. 22, T. 124 N., R. 63 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; moderate fine subangular blocky structure parting to moderate fine granular; hard, firm, sticky and plastic; many common fine and very fine roots; neutral; abrupt smooth boundary.

Bw1—7 to 18 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; weak coarse prismatic structure parting to moderate fine blocky; very hard, firm, sticky and plastic; common fine and very fine roots; neutral; clear wavy boundary.

Bw2—18 to 27 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; weak coarse prismatic structure parting to moderate fine and very fine angular blocky; very hard, firm, sticky and plastic; common fine and very fine roots; neutral; gradual wavy boundary.

Bw3—27 to 35 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; weak coarse prismatic structure parting to strong fine and very fine angular blocky; very hard, firm, sticky and plastic; few very fine roots; neutral; gradual wavy boundary.

Bw4—35 to 42 inches; gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; moderate medium and fine angular blocky structure; very hard, firm, sticky and plastic; neutral; clear wavy boundary.

Bk—42 to 50 inches; gray (5Y 7/1) silty clay, very dark gray (5Y 3/1) moist; weak medium and fine subangular blocky structure; very hard, firm, sticky and plastic; common fine accumulations of carbonate; slight effervescence; mildly alkaline; gradual wavy boundary.

C1—50 to 57 inches; olive gray (5Y 5/2) clay loam, olive gray (5Y 4/2) moist; common fine distinct yellowish brown (10YR 5/6) mottles; massive; very hard, friable; common fine accumulations of carbonate; slight effervescence; mildly alkaline; clear wavy boundary.

C2—57 to 60 inches; light olive gray (5Y 6/2) sandy clay loam, olive (5Y 4/3) moist; common fine distinct yellowish brown (10YR 5/6) mottles; massive; hard, friable; slight effervescence; neutral.

The mollic epipedon ranges from 24 to 55 inches in thickness. The depth to free carbonates ranges from 20 to 60 inches.

The A horizon has value of 4 or 5 (2 or 3 moist). It is silty clay or silty clay loam. It is 6 to 20 inches thick. The B horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 7 (2 to 5 moist), and chroma of 1 or 2. It is clay or silty clay. The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is silty clay loam, silty clay, sandy clay loam, or clay loam.

Eckman Series

The Eckman series consists of deep, well drained soils formed in glaciolacustrine sediments on glacial lake plains. Permeability is moderate. Slopes range from 0 to 9 percent.

Typical pedon of Eckman very fine sandy loam, in an area of Eckman-Gardena very fine sandy loams, 2 to 6 percent slopes; 2,350 feet east and 2,240 feet north of the southwest corner of sec. 7, T. 125 N., R. 60 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) very fine sandy loam, very dark gray (10YR 3/1) moist; weak medium subangular blocky structure parting to moderate fine granular; soft, very friable; many fine and very fine roots; neutral; abrupt smooth boundary.

A—8 to 12 inches; dark grayish brown (10YR 4/2) very fine sandy loam, very dark gray (10YR 3/1) moist; weak coarse subangular blocky structure; soft, very friable; common fine and very fine roots; neutral; clear smooth boundary.

Bw—12 to 24 inches; grayish brown (2.5Y 5/2) very fine sandy loam, dark grayish brown (2.5Y 4/2) moist; weak medium prismatic structure parting to weak coarse subangular blocky; soft, very friable; few very fine roots; moderately alkaline; gradual wavy boundary.

Bk—24 to 44 inches; light brownish gray (2.5Y 6/2) silt loam, grayish brown (2.5Y 5/2) moist; weak coarse subangular blocky structure; soft, very friable; common medium and fine accumulations of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

C—44 to 60 inches; light gray (2.5Y 7/2) very fine sandy loam, grayish brown (2.5Y 5/2) moist; massive; soft, very friable; varved; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 16 inches thick. The

depth to carbonates ranges from 10 to 36 inches.

The A horizon has value of 3 to 5 (2 or 3 moist) and chroma of 1 or 2. It is very fine sandy loam, loam, or silt loam. The Bw horizon has hue of 10YR or 2.5Y, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 4. It is very fine sandy loam, loam, or silt loam. The C horizon has value of 6 to 8 (5 or 6 moist) and chroma of 2 to 4. It is typically silt loam, very fine sandy loam, or loam, but in some pedons it is varved with very fine sand, silt, or silty clay.

Edgeley Series

The Edgeley series consists of moderately deep, well drained soils formed in glacial till or glaciofluvial deposits over shale. These soils are on dissected plains. Permeability is moderate above the shale. Slopes range from 1 to 20 percent.

Typical pedon of Edgeley loam, in an area of Edgeley-Kloten complex, 1 to 6 percent slopes; 2,170 feet east and 210 feet north of the southwest corner of sec. 26, T. 125 N., R. 65 W.

A—0 to 7 inches; dark grayish brown (10YR 4/2) loam, black (10YR 2/1) moist; weak fine granular structure; hard, friable; many fine and very fine roots; slightly acid; clear wavy boundary.

Bw1—7 to 14 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable; common very fine roots; slightly acid; clear wavy boundary.

Bw2—14 to 24 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak medium prismatic structure parting to weak coarse subangular blocky; hard, friable, sticky and plastic; common very fine roots; about 30 percent shale chips; neutral; clear wavy boundary.

2Cr1—24 to 38 inches; light gray (5Y 7/1) bedded shale, olive (5Y 5/3) moist; thin strata of gravelly sand between shale plates; neutral; diffuse wavy boundary.

2Cr2—38 to 60 inches; light gray (5Y 7/2) bedded shale, olive gray (5Y 5/2) moist; many fine strong brown (7.5YR 5/8) iron stains on surfaces of plates; mildly alkaline.

The mollic epipedon ranges from 7 to 16 inches in thickness. The depth to bedded shale ranges from 20 to 40 inches.

The A horizon has hue of 10YR or 2.5Y and value of 3 or 4 (2 or 3 moist). It is loam or clay loam. The Bw horizon has value of 4 to 6 (3 or 4 moist) and chroma of 1 or 2. It is loam, clay loam, silty clay loam, or shaly clay loam.

Egeland Series

The Egeland series consists of deep, well drained soils formed in glaciolacustrine and glacial outwash sediments on glacial lake plains. Permeability is moderately rapid. Slopes range from 0 to 6 percent.

Typical pedon of Egeland fine sandy loam, in an area of Egeland-Embden fine sandy loams, 2 to 6 percent slopes; 1,835 feet west and 750 feet south of the northeast corner of sec. 29, T. 126 N., R. 60 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak fine granular structure; soft, very friable; common very fine roots; slightly acid; abrupt smooth boundary.

Bw1—8 to 14 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; soft, very friable; few very fine roots; neutral; clear wavy boundary.

Bw2—14 to 27 inches; light brownish gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; soft, very friable; few very fine roots; neutral; clear wavy boundary.

Bk—27 to 38 inches; light brownish gray (2.5Y 6/2) loamy very fine sand, dark grayish brown (2.5Y 4/2) moist; weak coarse subangular blocky structure; soft, very friable; strong effervescence; mildly alkaline; gradual wavy boundary.

C—38 to 60 inches; light gray (2.5Y 7/2) loamy very fine sand, grayish brown (2.5Y 5/2) moist; massive; soft, very friable; slight effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 8 to 16 inches and extends into the B horizon in most pedons. The depth to carbonates ranges from 25 to 45 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is sandy loam, fine sandy loam, or loam. The Bw horizon has hue of 10YR or 2.5Y, value of 4 to 6 (1 to 4 moist), and chroma of 2 to 4. It is sandy loam or fine sandy loam. The Bk horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 or 5 moist), and chroma of 2 to 4. The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 or 5 moist), and chroma of 2 to 4. It is loamy sand, loamy

fine sand, sandy loam, loamy very fine sand, or fine sandy loam.

Embden Series

The Embden series consists of deep, well drained and moderately well drained soils formed in glaciolacustrine and glacial outwash sediments on glacial lake plains. Permeability is moderately rapid. Slopes range from 0 to 9 percent.

Typical pedon of Embden fine sandy loam, in an area of Swenoda-Embden fine sandy loams, 2 to 6 percent slopes; 2,455 feet east and 378 feet north of the southwest corner of sec. 8, T. 128 N., R. 60 W.

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

A—7 to 16 inches; dark gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak medium and fine granular; slightly hard, very friable; common very fine roots; neutral; clear wavy boundary.

Bw—16 to 27 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse and medium subangular blocky structure; slightly hard, very friable; common very fine roots; neutral; clear wavy boundary.

Bk—27 to 43 inches; light gray (2.5Y 7/2) fine sandy loam, light brownish gray (2.5Y 6/2) moist; weak coarse and medium subangular blocky structure; slightly hard, very friable; few very fine roots to a depth of 36 inches; common fine accumulations of carbonate; violent effervescence; moderately alkaline; clear wavy boundary.

C—43 to 60 inches; light gray (2.5Y 7/2) very fine sandy loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, very friable; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 16 to 40 inches in thickness. The depth to free carbonates ranges from 20 to 60 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is fine sandy loam, sandy loam, very fine sandy loam, or loam. The Bw horizon has hue of 10YR or 2.5Y, value of 3 to 5 (2 to 4 moist), and chroma of 1 to 3. It is fine sandy loam, sandy loam, very fine sandy loam, or loam. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 4 or less. It is fine sandy loam, sandy loam, loamy fine sand, or very fine sandy loam.

Exline Series

The Exline series consists of deep, moderately well drained and somewhat poorly drained soils formed in clayey glaciolacustrine sediments on glacial lake plains. Permeability is very slow. Slopes are less than 2 percent.

Typical pedon of Exline silt loam, in an area of Exline-Aberdeen-Nahon silt loams; 484 feet south and 120 feet east of the northwest corner of sec. 11, T. 122 N., R. 64 W.

A—0 to 2 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak fine and very fine granular structure; soft, friable; slightly acid; clear smooth boundary.

E—2 to 3 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak very thin platy structure; soft, friable; slightly acid; abrupt smooth boundary.

Bt—3 to 7 inches; dark gray (10YR 4/1) clay, black (10YR 2/1) moist; strong medium columnar structure parting to strong fine and medium blocky; very hard, very firm, very sticky and very plastic; thin continuous gray (10YR 5/1) coatings on the top of columns; continuous shiny films on vertical faces of peds; neutral; clear wavy boundary.

Btz—7 to 11 inches; dark gray (10YR 4/1) clay, black (10YR 2/1) crushing to very dark brown (10YR 2/2) moist; moderate medium prismatic structure parting to strong fine and very fine blocky; very hard, very firm, very sticky and very plastic; continuous shiny films on vertical faces of peds; common medium and fine crystals of salt; moderately alkaline; clear wavy boundary.

Btkz—11 to 19 inches; gray (10YR 5/1) clay, very dark gray (10YR 3/1) moist; weak very coarse prismatic structure parting to moderate fine and very fine blocky; very hard, very firm, very sticky and very plastic; continuous shiny films on vertical faces of peds; common fine accumulations of carbonate; many medium and fine crystals of salt; strong effervescence; moderately alkaline; gradual wavy boundary.

Bkz—19 to 23 inches; light brownish gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) moist; weak very fine blocky structure; very hard, very firm, very sticky and very plastic; common dark grayish brown (10YR 4/2) tongues, very dark brown (10YR 2/2) moist; common medium and fine accumulations of

carbonate; common fine crystals of salt; strong effervescence; strongly alkaline; gradual wavy boundary.

Bk—23 to 34 inches; light brownish gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; common fine distinct yellowish brown (10YR 5/6) and gray (5Y 5/1) mottles; weak fine and very fine blocky structure; very hard, firm, sticky and plastic; many grayish brown (2.5Y 5/2) tongues, very dark grayish brown (2.5Y 3/2) moist; few fine accumulations of carbonate; few fine crystals of salt; strong effervescence; strongly alkaline; gradual wavy boundary.

C—34 to 60 inches; light gray (2.5Y 7/2) silty clay loam, light olive brown (2.5Y 5/4) moist; many medium and fine distinct yellowish brown (10YR 5/6) and gray (5Y 5/1) mottles; massive; very hard, firm, sticky and plastic; varved; common medium and fine accumulations of carbonate in the upper part; strong effervescence; moderately alkaline.

The surface soil is 1 to 6 inches thick. The depth to free carbonates ranges from 8 to 19 inches. Crystals of gypsum and other salts are at a depth of 6 to 16 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is typically silt loam, loam, or silty clay loam, but in some pedons in cultivated areas it is silty clay. The E horizon has value of 5 or 6 (3 to 5 moist). It is silt loam, loam, or silty clay loam. The Bt horizon has hue of 10YR or 2.5Y and value of 3 to 5 (2 to 4 moist). It is silty clay or clay. The C horizon has hue of 2.5Y or 5Y, value of 5 to 8 (3 to 7 moist), and chroma of 2 to 4. It is silty clay loam, clay, or silty clay and is varved with very fine sand to clay. Some pedons have fine sand below a depth of 40 inches.

Ferney Series

The Ferney series consists of deep, moderately well drained and somewhat poorly drained soils formed in clayey glacial till on till plains. Permeability is very slow. Slopes range from 0 to 6 percent.

Typical pedon of Ferney clay loam, in an area of Cavour-Ferney complex; 2,525 feet west and 130 feet south of the northeast corner of sec. 36, T. 121 N., R. 60 W.

Ap—0 to 5 inches; dark gray (10YR 4/1) clay loam, black (10YR 2/1) moist; moderate medium and fine subangular blocky structure parting to moderate fine granular; slightly hard, friable; common fine and many very fine roots; few pebbles; neutral; abrupt smooth boundary.

Bt—5 to 10 inches; very dark grayish brown (10YR 3/2) clay loam, very dark brown (10YR 2/2) moist; strong medium columnar structure parting to strong medium and fine angular blocky; very hard, very firm, sticky and plastic; many very fine roots; thin continuous gray (10YR 6/1) coatings on the top of columns; shiny films on faces of peds; few pebbles; mildly alkaline; clear wavy boundary.

Btkz—10 to 25 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate coarse and medium prismatic structure parting to strong medium and fine angular blocky; hard, firm, sticky and plastic; common very fine roots; common medium and fine very dark grayish brown (10YR 3/2) tongues, very dark brown (10YR 2/2) moist; few pebbles; few fine accumulations of carbonate; many medium and fine nests of salt; strong effervescence; moderately alkaline; clear wavy boundary.

Bkz1—25 to 39 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; few fine prominent strong brown (7.5YR 4/6) and few fine distinct gray (10YR 5/1) mottles; weak coarse and medium prismatic structure parting to moderate medium and fine angular blocky; hard, firm, sticky and plastic; few very fine roots; common medium and fine very dark grayish brown (10YR 3/2) tongues, very dark brown (10YR 2/2) moist; few fine dark stains (manganese oxide); common fine accumulations of carbonate; common fine nests of salt; few pebbles; few shale chips; strong effervescence; moderately alkaline; clear wavy boundary.

Bkz2—39 to 50 inches; light yellowish brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) moist; common fine prominent strong brown (7.5YR 4/6) and many coarse and medium distinct gray (10YR 5/1) mottles; weak coarse prismatic structure parting to moderate medium and fine subangular blocky; hard, firm, sticky and plastic; few very fine roots; common medium and fine very dark grayish brown (10YR 3/2) tongues, very dark brown (10YR 2/2) moist; common fine dark stains (manganese oxide); common fine accumulations of carbonate; many coarse nests of salt; few pebbles; few shale chips; strong effervescence; moderately alkaline; gradual wavy boundary.

C—50 to 60 inches; light yellowish brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) moist; common fine prominent strong brown (7.5YR 4/6) and common medium and fine distinct gray (10YR 5/1) mottles; massive; hard, firm, sticky and plastic; common fine dark stains (manganese oxide);

common fine accumulations of carbonate; few nests of salt; few pebbles; few shale chips; strong effervescence; moderately alkaline.

The thickness of the A horizon is 2 to 6 inches. The depth to free carbonates and the depth to accumulations of salt range from 5 to 16 inches.

The A horizon has value of 4 or 5 (2 or 3 moist). It is clay loam, loam, or silt loam. Some pedons have an E horizon. The Bt horizon has hue of 10YR or 2.5Y, value of 3 to 6 (2 to 4 moist), and chroma of 1 to 4. It is clay loam or clay. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 8 (3 to 6 moist), and chroma of 2 to 4. It is clay loam or clay.

Fordville Series

The Fordville series consists of well drained soils formed in loamy sediments that are moderately deep over gravelly sand. These soils are on outwash plains and terraces. Permeability is moderate in the subsoil and rapid in the underlying gravelly sand. Slopes range from 0 to 6 percent.

Typical pedon of Fordville loam, 2,367 feet north and 327 feet east of the southwest corner of sec. 10, T. 128 N., R. 64 W.

A1—0 to 3 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak fine and very fine granular; slightly hard, very friable; many fine and very fine roots; slightly acid; clear smooth boundary.

A2—3 to 8 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak coarse and medium subangular blocky structure; slightly hard, very friable; many fine and very fine roots; slightly acid; clear smooth boundary.

Bw1—8 to 14 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak coarse and medium prismatic structure parting to weak coarse and medium subangular blocky; hard, friable; common fine and very fine roots; slightly acid; clear smooth boundary.

Bw2—14 to 24 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable; common fine and very fine roots; slightly acid; gradual wavy boundary.

2C1—24 to 28 inches; pale brown (10YR 6/3) gravelly sand, dark grayish brown (10YR 4/2) moist; single grain; loose; thick crusts of carbonates on undersides of pebbles; strong effervescence; mildly alkaline; gradual wavy boundary.

2C2—28 to 60 inches; pale brown (10YR 6/3) gravelly sand, dark grayish brown (10YR 4/2) moist; single grain; loose; strong effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 16 to 26 inches. The depth to gravelly sand ranges from 20 to 40 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is loam or silt loam. The Bw horizon has value of 3 to 5 (2 to 4 moist) and chroma of 2 to 4. It is loam, silt loam, or clay loam. Some pedons have a Bk horizon. The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 7 (4 to 6 moist), and chroma of 2 to 4. It is loamy sand, gravelly loamy sand, gravelly sand, or gravelly coarse sand.

Forman Series

The Forman series consists of deep, well drained soils formed in loamy glacial till on till plains and moraines. Permeability is moderate in the subsoil and moderately slow in the underlying material. Slopes range from 0 to 9 percent.

Typical pedon of Forman loam, in an area of Forman-Aastad loams, 0 to 3 percent slopes; 2,420 feet west and 250 feet north of the southeast corner of sec. 10, T. 125 N., R. 61 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, friable; many fine and very fine roots; neutral; abrupt smooth boundary.

Bt1—8 to 12 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate medium angular blocky; very hard, friable; common fine and very fine roots; continuous shiny films on faces of peds; common dark gray (10YR 4/1) tongues, black (10YR 2/1) moist; neutral; clear wavy boundary.

Bt2—12 to 16 inches; grayish brown (10YR 5/2) clay loam, dark brown (10YR 3/3) crushing to brown (10YR 4/3) moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable; few fine and very fine roots; discontinuous shiny films on faces of peds; few dark gray (10YR 4/1) tongues, black (10YR 2/1) moist; neutral; clear wavy boundary.

Bk—16 to 28 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak medium prismatic structure parting to weak coarse and medium subangular blocky; hard, friable; many medium and fine accumulations of carbonate; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—28 to 38 inches; light yellowish brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) moist; massive; hard, friable; few fine strong brown (7.5YR 5/6) iron stains; few fine concretions of manganese oxide; few fine accumulations of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—38 to 60 inches; pale yellow (2.5Y 7/4) clay loam, olive brown (2.5Y 4/4) moist; massive; hard, friable; few fine strong brown (7.5YR 5/6) iron stains; few fine concretions of manganese oxide; few fine accumulations of carbonate; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 9 to 16 inches in thickness. The depth to free carbonates ranges from 10 to 26 inches.

The A horizon has value of 3 or 4. It is loam or clay loam. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 to 3. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 moist, and chroma of 2 to 4. It is clay loam or loam.

Fossum Series

The Fossum series consists of deep, poorly drained and very poorly drained soils formed in sandy glaciolacustrine sediments in basins on glacial lake plains. Permeability is rapid. Slopes range from 0 to 2 percent.

Typical pedon of Fossum fine sandy loam, 950 feet north and 192 feet east of the southwest corner of sec. 27, T. 128 N., R. 60 W.

A1—0 to 8 inches; very dark gray (10YR 3/1) fine sandy loam, black (10YR 2/1) moist; weak fine granular structure; soft, very friable; many fine and very fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

A2—8 to 14 inches; very dark gray (10YR 3/1) loamy fine sand, black (10YR 2/1) moist; weak coarse subangular blocky structure parting to weak fine granular; soft, very friable; common fine and very fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

AC—14 to 30 inches; gray (5Y 5/1) fine sand, very dark gray (5Y 3/1) moist; single grain; loose; common fine and very fine roots; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg1—30 to 55 inches; light gray (5Y 7/1) fine sand, olive gray (5Y 5/2) moist; common fine faint yellowish brown (10YR 5/6) mottles; single grain; loose; few very fine roots to a depth of 40 inches; slight effervescence; moderately alkaline; gradual wavy boundary.

Cg2—55 to 60 inches; gray (5Y 6/1) fine sand, olive gray (5Y 4/2) moist; common fine faint yellowish brown (10YR 5/6) mottles; single grain; loose; slight effervescence; mildly alkaline.

The mollic epipedon ranges from 10 to 24 inches in thickness. The A horizon has hue of 10YR or 2.5Y, value of 3 or 4 (2 or 3 moist), and chroma of 1 or 2. It is loamy sand, loamy fine sand, sandy loam, or fine sandy loam. The C horizon has hue of 2.5Y or 5Y, value of 6 to 8 (4 to 6 moist), and chroma of 1 to 3. It is sand, fine sand, loamy sand, loamy fine sand, sandy loam, or fine sandy loam.

Gardena Series

The Gardena series consists of deep, well drained and moderately well drained soils formed in glaciolacustrine sediments on glacial lake plains. Permeability is moderate. Slopes range from 0 to 6 percent.

Typical pedon of Gardena very fine sandy loam, 2,000 feet north and 90 feet west of the southeast corner of sec. 7, T. 125 N., R. 60 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) very fine sandy loam, black (10YR 2/1) moist; weak coarse and medium subangular blocky structure parting to weak medium and fine granular; soft, very friable; common fine roots; neutral; abrupt smooth boundary.

A—8 to 20 inches; dark gray (10YR 4/1) very fine sandy loam, black (10YR 2/1) moist; weak coarse and medium subangular blocky structure parting to weak very fine granular; soft, friable; common fine roots; mildly alkaline; clear wavy boundary.

Bw—20 to 34 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable; few fine roots; mildly alkaline; gradual wavy boundary.

Bk—34 to 44 inches; light gray (2.5Y 7/2) silt loam, grayish brown (2.5Y 5/2) moist; weak coarse subangular blocky structure; slightly hard, friable; violent effervescence; moderately alkaline; gradual wavy boundary.

C—44 to 60 inches; light gray (2.5Y 7/2) silt loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, friable; few fine accumulations of carbonate; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 16 to 40 inches in thickness. The depth to free carbonates ranges from 14 to 40 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is loam, silt loam, or very fine sandy loam. The Bw horizon has hue of 10YR or 2.5Y, value of 3 to 5 (2 to 4 moist), and chroma of 1 to 3. It is loam, silt loam, or very fine sandy loam. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is loam, silt loam, or very fine sandy loam. In some pedons it is varved with very fine sand, silt, or silty clay in the lower part.

Glyndon Series

The Glyndon series consists of deep, moderately well drained and somewhat poorly drained soils formed in glaciolacustrine sediments on glacial lake plains. Permeability is moderate or moderately rapid. Slopes range from 0 to 3 percent.

Typical pedon of Glyndon silt loam, in an area of Gardena-Glyndon silt loams; 1,815 feet west and 128 feet south of the northeast corner of sec. 7, T. 125 N., R. 60 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to moderate fine granular; soft, very friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

A—8 to 14 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak fine subangular blocky; soft, friable; slight effervescence; mildly alkaline; abrupt wavy boundary.

Bk1—14 to 22 inches; white (2.5Y 8/2) silt loam, light brownish gray (2.5Y 6/2) moist; weak coarse subangular blocky structure; soft, friable; few dark gray (10YR 4/1) tongues, black (10YR 2/1) moist; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk2—22 to 32 inches; light gray (2.5Y 7/2) silt loam, light olive brown (2.5Y 5/4) moist; weak coarse subangular blocky structure; soft, friable; strong effervescence; strongly alkaline; gradual wavy boundary.

Bk3—32 to 38 inches; light gray (2.5Y 7/2) silt loam, light olive brown (2.5Y 5/4) moist; few fine distinct gray (10YR 5/1) and yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; soft, friable; strong effervescence; strongly alkaline; abrupt smooth boundary.

C—38 to 60 inches; light gray (2.5Y 7/2) silt loam, light olive brown (2.5Y 5/4) moist; many medium and fine distinct gray (10YR 5/1), common medium and fine prominent strong brown (7.5YR 5/8), and common fine distinct yellowish brown (10YR 5/8) mottles; massive; soft, friable; varved; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has value of 3 or 4 (2 or 3 moist) and chroma of 1 or 2. It is silt loam, very fine sandy loam, or loam. The Bk horizon has hue of 10YR or 2.5Y, value of 6 to 8 (4 to 6 moist), and chroma of 1 to 4. It is loamy very fine sand, very fine sandy loam, loam, or silt loam. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is very fine sand, loamy very fine sand, loam, silt loam, or very fine sandy loam.

Great Bend Series

The Great Bend series consists of deep, well drained soils formed in silty glaciolacustrine sediments on glacial lake plains. Permeability is moderate in the subsoil and moderate to slow in the underlying material. Slopes range from 0 to 9 percent.

Typical pedon of Great Bend silt loam, in an area of Great Bend-Beotia silt loams, 2 to 6 percent slopes; 1,100 feet south and 130 feet east of the northwest corner of sec. 29, T. 122 N., R. 62 W.

Ap—0 to 8 inches; grayish brown (10YR 5/2) silt loam, very dark gray (10YR 3/1) moist; weak fine granular structure; slightly hard, friable; many fine roots; neutral; abrupt smooth boundary.

Bw—8 to 13 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable; common fine roots; neutral; clear wavy boundary.

Bk1—13 to 17 inches; pale yellow (2.5Y 7/4) silt loam, light olive brown (2.5Y 5/4) moist; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, very friable; few fine roots; many fine pores; strong effervescence; mildly alkaline; clear wavy boundary.

Bk2—17 to 29 inches; pale yellow (2.5Y 7/4) silt loam, light olive brown (2.5Y 5/4) moist; weak coarse and medium subangular blocky structure; slightly hard, very friable; few roots; many fine pores; few fine threads of gypsum; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—29 to 46 inches; light gray (2.5Y 7/2) and light olive brown (2.5Y 5/4) silt loam, light yellowish brown (2.5Y 6/4) and olive brown (2.5Y 4/4) moist; massive; slightly hard, friable; varved; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—46 to 60 inches; white (2.5Y 8/2) silt loam that has

varves of silty clay and very fine sandy loam 1 to 3 millimeters thick; light yellowish brown (2.5Y 6/4) moist; common fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) mottles; massive; slightly hard, friable; few fine concretions of manganese oxide and iron oxide; few fine threads of gypsum crystals; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 6 to 16 inches. The depth to carbonates ranges from 10 to 32 inches.

The A horizon has value of 3 to 5 (2 or 3 moist). It is silt loam or silty clay loam. The Bw horizon has hue of 10YR or 2.5Y, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 4. It is silt loam or silty clay loam. The C horizon has value of 5 to 8 (4 to 6 moist). It is silt loam or silty clay loam and is varved with very fine sand to clay in the lower part. The varves range from less than 1 millimeter to 10 millimeters in thickness.

Hamar Series

The Hamar series consists of deep, somewhat poorly drained soils formed in sandy glaciolacustrine sediments on glacial lake plains. Permeability is rapid or moderately rapid. Slopes range from 0 to 3 percent.

Typical pedon of Hamar loamy fine sand, in an area of Hecla-Hamar loamy fine sands, 0 to 6 percent slopes; 2,490 feet north and 180 feet west of the southeast corner of sec. 34, T. 128 N., R. 61 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) loamy fine sand, black (10YR 2/1) moist; very weak fine granular structure; soft, very friable; common fine roots; slightly acid; abrupt smooth boundary.

A—7 to 17 inches; dark gray (10YR 4/1) loamy fine sand, very dark gray (10YR 3/1) moist; many fine distinct dark brown (7.5YR 4/4) mottles; weak coarse and medium subangular blocky structure; soft, very friable; common fine roots; neutral; gradual wavy boundary.

C1—17 to 36 inches; grayish brown (2.5Y 5/2) fine sand, dark grayish brown (2.5Y 4/2) moist; common fine distinct dark yellowish brown (10YR 4/4) mottles; single grain; loose; few fine roots; moderately alkaline; clear wavy boundary.

C2—36 to 42 inches; grayish brown (2.5Y 5/2) fine sand, dark grayish brown (2.5Y 4/2) moist; common fine distinct yellowish brown (10YR 5/6) mottles; single grain; loose; common fine dark stains (manganese oxide); slight effervescence; moderately alkaline; clear wavy boundary.

C3—42 to 52 inches; grayish brown (2.5Y 5/2) fine sand, dark grayish brown (2.5Y 4/2) moist; few fine distinct yellowish brown (10YR 5/6) mottles; single grain; loose; few fine dark stains (manganese oxide); slight effervescence; moderately alkaline; gradual wavy boundary.

C4—52 to 60 inches; grayish brown (2.5Y 5/2) fine sand, dark grayish brown (2.5Y 4/2) moist; few fine distinct yellowish brown (10YR 5/6) mottles; single grain; loose; slight effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 10 to 20 inches. The depth to free carbonates ranges from 22 to 50 inches. Some pedons have buried horizons below a depth of 30 inches.

The A horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 1 or 2. It is loamy fine sand, loamy sand, sandy loam, or fine sandy loam. Some pedons have an AC horizon. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 7 (3 to 5 moist), and chroma of 1 to 4. It is loamy fine sand, loamy sand, or fine sand.

Hamerly Series

The Hamerly series consists of deep, somewhat poorly drained and moderately well drained soils formed in glacial till on till plains. Permeability is moderate in the subsoil and moderately slow in the underlying material. Slopes range from 0 to 3 percent.

Typical pedon of Hamerly loam, in an area of Barnes-Hamerly-Tonka complex; 680 feet north and 230 feet west of the southeast corner of sec. 5, T. 127 N., R. 62 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, friable; common fine and very fine roots; strong effervescence; moderately alkaline; abrupt smooth boundary.

Bk1—7 to 12 inches; light gray (10YR 7/1) loam, grayish brown (10YR 5/2) moist; few fine faint yellowish brown (10YR 5/6) mottles; weak coarse and medium subangular blocky structure; hard, friable; common fine and very fine roots; violent effervescence; moderately alkaline; clear wavy boundary.

Bk2—12 to 24 inches; light brownish gray (2.5Y 6/2) clay loam, olive brown (2.5Y 4/4) moist; few fine faint yellowish brown (10YR 5/6) mottles; weak coarse and medium subangular blocky structure; hard, friable; few very fine roots; violent effervescence; moderately alkaline; clear wavy boundary.

C1—24 to 45 inches; light yellowish brown (2.5Y 6/4)

clay loam, olive brown (2.5Y 4/4) moist; many medium and fine distinct gray (10YR 6/1) mottles; massive; hard, friable; few very fine roots to a depth of 30 inches; few fine distinct strong brown (7.5YR 5/6) iron stains; few fine accumulations of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—45 to 60 inches; light yellowish brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) moist; many coarse and medium distinct gray (10YR 6/1) mottles; massive; hard, friable; few fine strong brown (7.5YR 5/6) iron stains; few fine accumulations of carbonate; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 15 inches thick. In some areas that support native grasses, the upper few inches are leached of carbonates.

The A horizon has hue of 10YR or 2.5Y, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is loam or silt loam. The Bk horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 1 to 4. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 1 to 4. It is loam or clay loam.

Harmony Series

The Harmony series consists of deep, moderately well drained soils formed in glaciolacustrine sediments on glacial lake plains. Permeability is moderately slow in the subsoil and moderate to slow in the underlying material. Slopes range from 0 to 2 percent.

Typical pedon of Harmony silty clay loam, in an area of Harmony-Aberdeen silty clay loams; 2,385 feet south and 1,240 feet west of the northeast corner of sec. 4, T. 122 N., R. 63 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak medium and fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; neutral; abrupt smooth boundary.

A—8 to 15 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to moderate medium and fine granular; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; neutral; clear wavy boundary.

Bt1—15 to 19 inches; dark gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; weak coarse and medium prismatic structure parting to strong fine and very fine subangular blocky; hard, friable, sticky and plastic; common fine roots; continuous shiny films on vertical faces of peds; neutral; clear wavy boundary.

Bt2—19 to 28 inches; grayish brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate medium and fine blocky; hard, firm, sticky and plastic; common fine roots; continuous shiny films on vertical faces of peds; neutral; clear wavy boundary.

Bt3—28 to 35 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate coarse and medium prismatic structure parting to moderate medium and fine blocky; hard, firm, sticky and plastic; few fine roots; continuous shiny films on vertical faces of peds; few dark gray (10YR 4/1) tongues, very dark gray (10YR 3/1) moist; neutral; clear wavy boundary.

Bk—35 to 40 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; weak medium subangular blocky structure; hard, friable, sticky and plastic; few fine roots; common fine accumulations of carbonate; strong effervescence; mildly alkaline; clear wavy boundary.

C—40 to 60 inches; light gray (2.5Y 7/2) loam, grayish brown (2.5Y 5/2) moist; common fine distinct yellowish brown (10YR 5/6) and few fine distinct grayish brown (2.5Y 5/2) mottles; massive; slightly hard, very friable; varved; slight effervescence; moderately alkaline.

The mollic epipedon is 16 to 30 inches thick. The depth to free carbonates ranges from 16 to 38 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is silt loam or silty clay loam. Some pedons have a BA horizon. The Bt horizon has value of 4 to 6 (3 or 4 moist) and chroma of 1 or 2. The C horizon has hue of 2.5Y or 5Y, value of 6 to 8 (4 to 6 moist), and chroma of 2 to 4. It is silt loam, silty clay loam, or loam. It typically is varved with very fine sand to clay. The varves range from less than 1 millimeter to 10 millimeters in thickness.

Harmony Variant

The Harmony Variant consists of moderately well drained soils formed in alluvium that is moderately deep over sand. These soils are on outwash plains. Permeability is moderate or moderately slow in the subsoil and rapid in the underlying sand. Slopes range from 0 to 2 percent.

Typical pedon of Harmony Variant clay loam, 125 feet south and 100 feet west of the northeast corner of sec. 32, T. 124 N., R. 63 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) clay loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to moderate medium granular; hard, friable; moderately alkaline; abrupt smooth boundary.

Bt1—8 to 17 inches; dark gray (10YR 4/1) clay loam, black (10YR 2/1) moist; moderate coarse and medium prismatic structure parting to moderate medium and fine angular blocky; hard, firm, slightly sticky and slightly plastic; moderately alkaline; clear wavy boundary.

Bt2—17 to 22 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to moderate medium and fine angular blocky; hard, firm, slightly sticky and slightly plastic; common fine dark stains (manganese oxide); strongly alkaline; clear wavy boundary.

Bk—22 to 30 inches; light gray (2.5Y 7/2) loam, light brownish gray (2.5Y 6/2) moist; weak coarse subangular blocky structure parting to weak medium and fine subangular blocky; slightly hard, friable; violent effervescence; very strongly alkaline; gradual wavy boundary.

2C1—30 to 46 inches; light brownish gray (2.5Y 6/2) loamy fine sand, dark grayish brown (2.5Y 4/2) moist; single grain; loose; strong effervescence; strongly alkaline; gradual wavy boundary.

2C2—46 to 60 inches; light brownish gray (2.5Y 6/2) fine sand, dark grayish brown (2.5Y 4/2) moist; single grain; loose; slight effervescence; strongly alkaline.

The thickness of the mollic epipedon and the depth to free carbonates range from 16 to 25 inches. Depth to the sandy material ranges from 20 to 40 inches.

The Ap horizon has value of 4 or 5 (2 or 3 moist). It is clay loam, silty clay loam, or loam. It is 7 to 10 inches thick. The Bt horizon has value of 2 to 4 moist. It is clay loam or silty clay. The 2C horizon has hue of 10YR or 2.5Y, value of 6 or 7 (4 or 5 moist), and chroma of 2 to 4. It is loamy fine sand, fine sand, or sand.

Harriet Series

The Harriet series consists of deep, poorly drained soils formed in alluvium on flood plains. Permeability is very slow. Slopes are less than 1 percent.

Typical pedon of Harriet loam, 1,775 feet west and 150 feet south of the northeast corner of sec. 7, T. 126 N., R. 65 W.

E—0 to 2 inches; gray (10YR 6/1) loam, very dark gray (10YR 3/1) moist; weak thin platy structure parting to weak fine granular; soft, very friable; many fine and very fine roots; neutral; abrupt smooth boundary.

Bt—2 to 5 inches; dark gray (10YR 4/1) clay loam, black (10YR 2/1) moist; moderate medium columnar structure parting to moderate medium and fine angular blocky; very hard, very firm, sticky and plastic; common very fine roots; thin continuous gray (10YR 6/1) coatings on the top of columns; few fine nests of salt in the lower part; slight effervescence; mildly alkaline; clear wavy boundary.

Btz—5 to 13 inches; dark gray (10YR 4/1) clay loam, black (10YR 2/1) moist; moderate medium prismatic structure parting to moderate medium and fine angular blocky; very hard, firm, sticky and plastic; common very fine roots; many fine nests of salt; strong effervescence; moderately alkaline; clear wavy boundary.

Bz—13 to 26 inches; gray (10YR 5/1) clay loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; very hard, firm, sticky and plastic; few very fine roots; many crystals and fine nests of salt; violent effervescence; strongly alkaline; clear wavy boundary.

C—26 to 35 inches; gray (10YR 5/1) clay loam, very dark grayish brown (10YR 3/2) moist; massive; very hard, firm, sticky and plastic; few very fine roots; violent effervescence; strongly alkaline; gradual wavy boundary.

Cg1—35 to 45 inches; gray (5Y 5/1) clay loam, very dark gray (5Y 3/1) moist; massive; very hard, firm, sticky and plastic; many medium and fine accumulations of carbonate; violent effervescence; moderately alkaline; gradual wavy boundary.

Cg2—45 to 60 inches; gray (5Y 5/1) clay loam, very dark gray (5Y 3/1) moist; many fine distinct reddish brown (5YR 4/4) mottles; massive; very hard, firm, sticky and plastic; strong effervescence; moderately alkaline.

Salts typically are at a depth of 4 to 11 inches and in places are throughout the soils. Some pedons have a dark A horizon, which is 1 or 2 inches thick.

The E horizon has value of 5 or 6 (3 or 4 moist). It is loam or silt loam. It is 1 to 5 inches thick. The Bt horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is silty clay, clay loam, or clay. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 7 (3 to 5 moist), and chroma of 1 to 3. It typically is stratified very fine sandy loam, loam, silty clay loam, clay loam, or silty clay. Some pedons are stratified with coarser textured material below a depth of 30 inches.

Hecla Series

The Hecla series consists of deep, moderately well drained soils formed in sandy sediments on glacial lake plains. Permeability is moderately rapid or rapid. Slopes range from 0 to 6 percent.

Typical pedon of Hecla loamy fine sand, in an area of Maddock-Hecla-Hamar loamy fine sands, 2 to 8 percent slopes; 510 feet west and 130 feet north of the southeast corner of sec. 36, T. 127 N., R. 61 W.

A1—0 to 6 inches; dark gray (10YR 4/1) loamy fine sand, black (10YR 2/1) moist; weak fine granular structure; soft, very friable; many medium and fine roots; neutral; clear smooth boundary.

A2—6 to 20 inches; dark gray (10YR 4/1) fine sand, very dark gray (10YR 3/1) moist; single grain; loose; common medium and fine roots; neutral; clear wavy boundary.

AC—20 to 30 inches; dark gray (10YR 4/1) fine sand, very dark gray (10YR 3/1) moist; very weak medium subangular blocky structure and single grain; loose, very friable; few medium and fine roots; neutral; gradual wavy boundary.

C1—30 to 46 inches; grayish brown (10YR 5/2) fine sand, dark grayish brown (10YR 4/2) moist; few fine distinct dark yellowish brown (10YR 4/4) mottles; single grain; loose; few medium and fine roots; few very fine bands, very dark grayish brown (10YR 3/2) moist; mildly alkaline; gradual wavy boundary.

C2—46 to 54 inches; grayish brown (2.5Y 5/2) fine sand, dark grayish brown (2.5Y 4/2) moist; common fine distinct yellowish brown (10YR 5/6) and dark yellowish brown (10YR 4/4) mottles; single grain; loose; few medium and fine roots; mildly alkaline; clear wavy boundary.

Ab—54 to 60 inches; very dark gray (10YR 3/1) fine sandy loam, black (10YR 2/1) moist; common fine distinct dark yellowish brown (10YR 4/4) mottles; massive; soft, very friable; few medium and fine roots; mildly alkaline.

The thickness of the mollic epipedon ranges from 10 to 20 inches. Between depths of 20 and 40 inches, the horizons that have value of less than 5.5 dry and 3.5 moist have less than 0.6 percent organic carbon. The depth to free carbonates ranges from 20 to more than 60 inches.

The A horizon has value of 3 or 4 and chroma of 1 or 2. It is loamy fine sand, loamy sand, sandy loam, or fine sandy loam in the upper part and loamy fine sand, loamy sand, or fine sand in the lower part. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 7 (3 to 5 moist), and chroma of 2 to 4. It is loamy fine sand, loamy sand, or fine sand. Some pedons do not have a buried A horizon. Silty material is below a depth of 40 inches in some pedons.

Heil Series

The Heil series consists of deep, poorly drained soils formed in clayey alluvium on till plains. Permeability is very slow. Slopes are less than 1 percent.

Typical pedon of Heil silt loam, 1,850 feet south and 175 feet east of the northwest corner of sec. 30, T. 125 N., R. 65 W.

E—0 to 2 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak thin and very thin platy structure parting to weak fine and very fine granular; soft, friable; many fine and very fine roots; medium acid; abrupt wavy boundary.

Bt1—2 to 8 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; few fine faint dark brown (10YR 3/3) and dark yellowish brown (10YR 3/4) mottles; strong coarse columnar structure parting to strong coarse and medium blocky; very hard, very firm, sticky and plastic; many very fine roots along faces of peds; thin continuous gray (10YR 6/1) coatings on the top of columns; common gray (10YR 5/1) tongues, very dark gray (10YR 3/1) moist; few fine distinct strong brown (7.5YR 5/6) iron stains; neutral; gradual smooth boundary.

Bt2—8 to 16 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; strong coarse prismatic structure parting to strong coarse and medium blocky; very hard, very firm, sticky and plastic; common very fine roots; neutral; gradual wavy boundary.

Bzg1—16 to 26 inches; dark gray (5Y 4/1) silty clay, very dark gray (5Y 3/1) moist; moderate medium blocky structure; very hard, very firm, sticky and plastic; few medium and fine nests of salt; mildly alkaline; gradual wavy boundary.

Bzg2—26 to 35 inches; dark gray (5Y 4/1) silty clay, very dark gray (5Y 3/1) moist; weak coarse blocky structure; very hard, very firm, sticky and plastic; few medium and fine nests of salt; slight effervescence; mildly alkaline; gradual wavy boundary.

Cg1—35 to 45 inches; gray (5Y 6/1) clay loam, dark gray (5Y 4/1) moist; common fine distinct dark yellowish brown (10YR 4/6) mottles; massive; hard, firm, sticky and plastic; common fine accumulations of carbonate; few fine nests of salt; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg2—45 to 60 inches; light gray (5Y 7/2) clay loam,

olive gray (5Y 5/2) moist; common fine distinct dark yellowish brown (10YR 4/6) mottles; massive; hard, firm, sticky and plastic; common fine accumulations of carbonate; few fine nests of salt; strong effervescence; moderately alkaline.

The depth to free carbonates ranges from 15 to 38 inches. Some pedons have an A horizon, which is 1 to 3 inches thick. The thickness of the A horizon combined with that of the E horizon ranges from 1 to 4 inches.

The E horizon has value of 4 to 6 (3 to 5 moist). It is silt loam or silty clay loam. It is 1 to 4 inches thick. The Bt horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5 (3 or 4 moist), and chroma of 1 or 2. It is silty clay or clay. Some pedons do not have a Bzg horizon. The Cg horizon is silty clay, clay, clay loam, or silty clay loam.

Huffton Series

The Huffton series consists of deep, well drained soils formed in silty glaciolacustrine sediments on glacial lake plains. Permeability is moderate in the subsoil and moderate to slow in the underlying material. Slopes range from 1 to 9 percent.

Typical pedon of Huffton silt loam, in an area of Bearden-Huffton silt loams, 1 to 6 percent slopes; 2,084 feet east and 92 feet north of the southwest corner of sec. 23, T. 124 N., R. 61 W.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silt loam, very dark gray (10YR 3/1) moist; weak very fine granular structure; slightly hard, very friable; common very fine roots; strong effervescence (5 percent calcium carbonate); mildly alkaline; clear smooth boundary.

Bk—7 to 13 inches; grayish brown (10YR 5/2) and light gray (10YR 7/2) silt loam, very dark grayish brown (10YR 3/2) and grayish brown (10YR 5/2) moist; weak coarse and medium subangular blocky structure; slightly hard, very friable; few very fine roots; common fine pores; common medium and fine accumulations of carbonate; few fine nests of gypsum crystals and other salts; strong effervescence (20 percent calcium carbonate); moderately alkaline; clear wavy boundary.

Bkz1—13 to 19 inches; light gray (2.5Y 7/2) silt loam, light olive brown (2.5Y 5/4) moist; weak coarse and medium subangular blocky structure; slightly hard, very friable; few very fine roots; many fine pores; few fine accumulations of carbonate; many fine nests of gypsum crystals and other salts; violent effervescence (30 percent calcium carbonate); moderately alkaline; clear wavy boundary.

Bkz2—19 to 30 inches; pale yellow (2.5Y 7/4) silt loam, light olive brown (2.5Y 5/4) moist; weak coarse and medium subangular blocky structure; slightly hard, very friable; few very fine roots; many fine pores; few fine accumulations of carbonate; common fine nests of gypsum crystals and other salts; violent effervescence (18 percent calcium carbonate); strongly alkaline; gradual wavy boundary.

C1—30 to 43 inches; pale yellow (2.5Y 7/4) silt loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, very friable; varves 1 to 2 millimeters thick; few fine nests of gypsum crystals and other salts; strong effervescence (10 percent calcium carbonate); strongly alkaline; clear smooth boundary.

C2—43 to 60 inches; light gray (2.5Y 7/2) silt loam, light olive brown (2.5Y 5/4) moist; few fine distinct brownish yellow (10YR 6/6) mottles; massive; soft, very friable; varves 1 to 2 millimeters thick; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon typically is 7 to 9 inches but ranges from 6 to 16 inches. Crystals of gypsum and other salts are at a depth of 6 to 35 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It typically is silt loam but is very fine sandy loam or loam in some pedons. The Bk horizon has value of 5 to 7 (3 to 6 moist) and chroma of 2 to 4. It is silt loam, loam, or very fine sandy loam. The C horizon has hue of 10YR or 2.5Y, value of 6 to 8 (4 to 6 moist), and chroma of 2 to 4. It is silt loam, loam, or very fine sandy loam and is varved. The varves range from 1 to 5 millimeters in thickness.

Kloten Series

The Kloten series consists of shallow, well drained soils formed in a thin layer of glacial till, which is underlain by shale. These soils are on dissected plains. Permeability is moderate above the shale. Slopes range from 3 to 35 percent.

Typical pedon of Kloten clay loam, in an area of Zahl-Kloten-Edgeley complex, 9 to 35 percent slopes; 1,790 feet east and 357 feet north of the southwest corner of sec. 26, T. 125 N., R. 65 W.

A—0 to 6 inches; dark gray (10YR 4/1) clay loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, very friable; many fine and very fine roots; few shale chips; neutral; clear wavy boundary.

C1—6 to 12 inches; light brownish gray (2.5Y 6/2) clay loam, very dark grayish brown (2.5Y 3/2) moist; weak medium prismatic structure parting to weak

fine subangular blocky; slightly hard, very friable; many fine and very fine roots; few shale chips in the upper part, increasing in abundance in the lower part; neutral; clear wavy boundary.

C2—12 to 18 inches; gray (5Y 5/1) clay loam, very dark gray (5Y 3/1) moist; weak medium and moderate fine and very fine subangular blocky structure; slightly hard, very friable; few medium and fine accumulations of carbonate; about 40 percent shale chips; slight effervescence; mildly alkaline; clear wavy boundary.

2Cr—18 to 60 inches; gray (5Y 6/1) bedded shale, very dark gray (5Y 3/1) moist; thin strata of gravelly sand between shale plates; many medium and fine strong brown (7.5YR 5/8) iron stains on surfaces of plates; mildly alkaline.

The depth to bedded shale ranges from 9 to 20 inches. The A horizon has value of 3 to 5 (2 or 3 moist). It is loam or clay loam. The C horizon has value of 4 to 6 (3 to 5 moist). It is loam or clay loam.

Koto Series

The Koto series consists of deep, poorly drained soils formed in loamy glacial outwash sediments over glacial till. These soils are on till plains. Permeability is slow. Slopes are less than 1 percent.

Typical pedon of Koto loam, in an area of Koto-Harriet loams; 1,950 feet east and 290 feet north of the southwest corner of sec. 5, T. 125 N., R. 65 W.

A—0 to 8 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak very fine granular structure; slightly hard, very friable; many fine roots; medium acid; abrupt smooth boundary.

E—8 to 11 inches; light gray (10YR 7/1) sandy loam, dark grayish brown (10YR 4/2) moist; common fine distinct yellowish brown (10YR 5/4) and dark brown (7.5YR 4/4) mottles; weak thin platy structure; soft, very friable; common very fine roots; common fine and very fine pores; slightly acid; clear irregular boundary.

Bt1—11 to 18 inches; grayish brown (10YR 5/2) sandy clay loam, very dark grayish brown (10YR 3/2) moist; few fine distinct light olive brown (2.5Y 5/4) mottles; strong coarse columnar structure parting to moderate coarse and medium blocky; hard, very friable; common very fine roots; common fine pores; thin continuous light gray (10YR 7/1) and gray (10YR 6/1) coatings on the top and sides of prisms; common medium and fine dark stains (iron and manganese oxide) on faces of peds and along root pores; medium acid; clear wavy boundary.

Bt2—18 to 27 inches; grayish brown (10YR 5/2) sandy clay loam, dark grayish brown (10YR 4/2) moist; few fine distinct yellowish brown (10YR 5/6) mottles in interiors of peds; strong very coarse and coarse prismatic structure parting to moderate coarse and medium subangular blocky; hard, friable; common very fine roots; common fine pores; continuous shiny films on vertical faces of peds; common fine dark stains (iron and manganese oxide) in interiors of peds and along root pores; medium acid; clear wavy boundary.

Btk—27 to 32 inches; light brownish gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; common medium and fine distinct yellowish brown (10YR 5/6) mottles; moderate medium and fine blocky structure; slightly hard, very friable; few very fine roots; common fine pores; common grayish brown (10YR 5/2) tongues ¼ to ½ inch thick, dark grayish brown (10YR 4/2) moist; common fine accumulations of carbonate; violent effervescence; mildly alkaline; clear wavy boundary.

Bk—32 to 42 inches; light gray (2.5Y 7/2) sandy loam, grayish brown (2.5Y 5/2) moist; common medium and fine distinct yellowish brown (10YR 5/6) and common fine distinct gray (10YR 6/1) mottles; weak medium and fine subangular blocky structure; slightly hard, very friable; common fine pores; bedding planes evident; common fine accumulations of carbonate; strong effervescence; moderately alkaline; clear smooth boundary.

2C1—42 to 55 inches; light gray (2.5Y 7/2) loam, grayish brown (2.5Y 5/2) moist; many medium and fine distinct dark brown (7.5YR 4/4) and gray (10YR 6/1) mottles; massive; slightly hard, very friable; few fine pores; few fine accumulations of carbonate; about 10 percent pebbles; strong effervescence; moderately alkaline; clear smooth boundary.

2C2—55 to 60 inches; light yellowish brown (2.5Y 6/4) loam, light olive brown (2.5Y 5/4) moist; common fine distinct yellowish brown (10YR 5/6) and gray (10YR 6/1) mottles; massive; slightly hard, very friable; few small pebbles; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 7 to 19 inches in thickness. The surface soil is 7 to 19 inches thick. The depth to free carbonates typically is 25 to 40 inches but ranges from 25 to 60 inches.

The A horizon has value of 3 to 5 (2 to 4 moist). It is loam, fine sandy loam, or sandy loam. The E horizon has value of 6 or 7 (3 to 5 moist). It is fine sandy loam, sandy loam, loamy fine sand, or loamy sand. The Bt horizon has hue of 10YR or 2.5Y, value of 4 to 7 (3 to 5 moist), and chroma of 1 or 2. It is clay loam, sandy clay

loam, or sandy loam. Some pedons do not have a Bk horizon. The 2C horizon has hue of 10YR, 2.5Y, or 5Y, value of 6 to 8 (4 to 6 moist), and chroma of 1 to 4. It is clay loam or loam.

Kranzburg Series

The Kranzburg series consists of deep, well drained soils formed in silty material over glacial till. These soils are on till plains and moraines. Permeability is moderate in the silty material and moderately slow in the underlying glacial till. Slopes range from 0 to 9 percent.

Typical pedon of Kranzburg silt loam, in an area of Kranzburg-Brookings-Buse complex, 1 to 6 percent slopes; 1,400 feet north and 200 feet west of the southeast corner of sec. 24, T. 122 N., R. 60 W.

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

Bw1—7 to 14 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak coarse and medium prismatic structure parting to weak coarse and medium subangular blocky; slightly hard, friable; many very fine roots; slightly acid; clear wavy boundary.

Bw2—14 to 24 inches; brown (10YR 5/3) silt loam, dark brown (10YR 4/3) moist; weak coarse and medium prismatic structure parting to weak coarse and medium subangular blocky; slightly hard, friable; common very fine roots; neutral; clear wavy boundary.

2Bk—24 to 36 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; weak coarse and medium subangular blocky structure; hard, firm; few very fine roots; strong effervescence; moderately alkaline; clear wavy boundary.

2C1—36 to 48 inches; pale yellow (2.5Y 7/4) clay loam, light olive brown (2.5Y 5/4) moist; massive; hard, firm; strong effervescence; moderately alkaline; gradual wavy boundary.

2C2—48 to 60 inches; light gray (2.5Y 7/2) clay loam, light olive brown (2.5Y 5/4) moist; massive; hard, firm; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The depth to free carbonates ranges from 20 to 32 inches. The depth to glacial till ranges from 20 to 40 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is silt loam or silty clay loam. The Bw horizon has hue of 10YR or 2.5Y and value of 3 to 5 (2 to 4 moist). It is silt loam or silty clay loam. Some pedons do not have a Bk horizon. The 2C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is clay loam or loam.

Kratka Series

The Kratka series consists of deep, poorly drained soils formed in sandy sediments over silty glaciolacustrine sediments. These soils are on glacial lake plains. Permeability is moderately rapid in the sandy sediments and moderate or moderately slow in the underlying material. Slopes are less than 1 percent.

Typical pedon of Kratka loamy fine sand, 1,110 feet south and 240 feet east of the northwest corner of sec. 26, T. 126 N., R. 61 W.

A—0 to 10 inches; dark gray (10YR 4/1) loamy fine sand, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak fine granular; soft, very friable; many fine and very fine roots; neutral; clear wavy boundary.

Bg1—10 to 16 inches; grayish brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; few fine distinct light olive brown (2.5Y 5/4) mottles; weak coarse and medium subangular blocky structure; slightly hard, very friable; common fine and very fine roots; few fine dark stains (manganese oxide); neutral; clear wavy boundary.

Bg2—16 to 22 inches; grayish brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; common fine distinct light olive brown (2.5Y 5/4) mottles; weak coarse and medium subangular blocky structure; slightly hard, very friable; common fine and very fine roots; common fine dark stains (manganese oxide); neutral; clear wavy boundary.

Bkg1—22 to 27 inches; light brownish gray (2.5Y 6/2) loamy fine sand, dark grayish brown (2.5Y 4/2) moist; few fine distinct light olive brown (2.5Y 5/4) mottles; weak medium and fine subangular blocky structure; slightly hard, very friable; few very fine roots; common fine accumulations of carbonate; strong effervescence; mildly alkaline; clear wavy boundary.

2Bkg2—27 to 39 inches; light gray (5Y 7/2) silt loam, pale olive (5Y 6/3) moist; common fine distinct light olive brown (2.5Y 5/6) mottles; weak coarse subangular blocky structure; slightly hard, friable; few very fine roots; common medium and fine accumulations of carbonate and few large and medium concretions of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

2Cg1—39 to 50 inches; white (5Y 8/1) silt loam, light

olive gray (5Y 6/2) moist; many medium and fine distinct brownish yellow (10YR 6/6) and yellowish brown (10YR 5/6) mottles; massive; slightly hard, friable; few fine strong brown (7.5YR 5/6) iron stains; few large and medium concretions of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

2Cg2—50 to 60 inches; white (5Y 8/1) silt loam, light olive gray (5Y 6/2) moist; many medium and fine distinct brownish yellow (10YR 6/6) and yellowish brown (10YR 5/6) mottles; massive; slightly hard, friable; few fine strong brown (7.5YR 5/6) iron stains; few large and medium concretions of carbonate; strong effervescence; mildly alkaline.

The thickness of the mollic epipedon typically ranges from 8 to 18 inches. The depth to silty lacustrine sediments ranges from 20 to 40 inches. The depth to free carbonates ranges from 20 to 45 inches.

The A horizon has hue of 10YR or 2.5Y, value of 3 or 4 (2 or 3 moist), and chroma of 1 or 2. It is loamy fine sand, fine sandy loam, or sandy loam. The Bg horizon has hue of 10YR or 2.5Y and value of 5 to 7 (4 to 6 moist). It has chroma of 1 or 2 in the upper part and 1 to 4 in the lower part. It is loamy fine sand, fine sand, loamy sand, or sand. The 2Cg horizon has hue of 10YR, 2.5Y, or 5Y, value of 6 to 8 (5 or 6 moist), and chroma of 1 to 3. It is silt loam, silty clay loam, loam, or clay loam.

LaDelle Series

The LaDelle series consists of deep, moderately well drained soils formed in silty alluvium on flood plains and stream terraces. Permeability is moderate. Slopes range from 0 to 2 percent.

Typical pedon of LaDelle silt loam, 2,410 feet north and 170 feet west of the southeast corner of sec. 15, T. 127 N., R. 64 W.

A1—0 to 7 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak coarse and medium subangular blocky structure parting to weak medium and fine subangular blocky; slightly hard, friable; many fine roots; neutral; clear smooth boundary.

A2—7 to 15 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak coarse and medium prismatic structure parting to weak coarse and medium subangular blocky; slightly hard, friable; many fine roots; neutral; clear wavy boundary.

Bk1—15 to 24 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak medium and fine subangular blocky structure; slightly hard, friable; many fine roots; common fine accumulations of carbonate; strong effervescence; mildly alkaline; gradual wavy boundary.

Bk2—24 to 34 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak medium and fine subangular blocky structure; hard, friable; common fine roots; few fine accumulations of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

C—34 to 60 inches; grayish brown (2.5Y 5/2) silt loam, dark grayish brown (2.5Y 4/2) moist; common fine faint dark brown (10YR 3/3) mottles; massive; hard, friable; few fine roots; common fine accumulations of carbonate; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 20 to 50 inches. The depth to free carbonates ranges from 0 to 30 inches. Some pedons have gypsum and other salts below a depth of 20 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is silt loam, loam, or silty clay loam. Some pedons have a Bw horizon, and some have an Ab horizon below a depth of 20 inches. The C horizon has hue of 10YR or 2.5Y, value of 3 to 7 (2 to 5 moist), and chroma of 1 to 3. It is commonly silty clay loam, silt loam, or loam, but it has strata of sand, silt, or clay below a depth of 40 inches in some pedons.

Lamoure Series

The Lamoure series consists of deep, somewhat poorly drained and poorly drained soils formed in alluvium on flood plains. Permeability is moderate or moderately slow. Slopes range from 0 to 2 percent.

Typical pedon of Lamoure silty clay loam, 1,230 feet west and 90 feet north of the southeast corner of sec. 2, T. 123 N., R. 62 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak very fine granular structure; slightly hard, friable; few very fine roots; strong effervescence; mildly alkaline; abrupt smooth boundary.

A1—7 to 16 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak coarse and medium prismatic structure parting to weak fine subangular blocky; hard, firm; few very fine roots; strong effervescence; mildly alkaline; gradual wavy boundary.

A2—16 to 36 inches; gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; weak coarse and medium prismatic structure parting to weak fine subangular blocky; slightly hard, friable; many fine accumulations of carbonate; strong effervescence;

moderately alkaline; clear wavy boundary.

Cg—36 to 40 inches; gray (5Y 6/1) silty clay loam, dark gray (5Y 4/1) moist; massive; hard, friable; common fine accumulations of carbonate; strong effervescence; moderately alkaline; clear wavy boundary.

Ab—40 to 45 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; massive; hard, friable; strong effervescence; mildly alkaline; clear wavy boundary.

2Cg—45 to 60 inches; white (5Y 8/1) loamy very fine sand, light olive gray (5Y 6/2) moist; few fine distinct yellowish brown (10YR 5/6) mottles; massive; soft, very friable; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 24 to 42 inches. The depth to carbonates ranges from 0 to 10 inches.

The A horizon has hue of 10YR, 2.5Y, or 5Y and value of 3 to 5 (2 or 3 moist). It is silty clay loam or silt loam. The Cg horizon has hue of 2.5Y or 5Y or is neutral in hue. It has value of 4 to 8 (3 to 6 moist) and chroma of 0 to 2. It is silty clay loam or silt loam. Some pedons do not have an Ab horizon. The 2Cg horizon is stratified sand, gravelly sand, loamy very fine sand, or loamy sand.

La Prairie Series

The La Prairie series consists of deep, moderately well drained soils formed in loamy alluvium on stream terraces. Permeability is moderate. Slopes range from 0 to 2 percent.

Typical pedon of La Prairie loam, in an area of La Prairie-Harriet loams; 1,870 feet south and 425 feet east of the northwest corner of sec. 32, T. 126 N., R. 65 W.

A1—0 to 10 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium subangular blocky structure; slightly hard, very friable; many fine and very fine roots; neutral; clear wavy boundary.

A2—10 to 16 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak coarse and medium subangular blocky structure; slightly hard, very friable; common very fine roots; neutral; clear wavy boundary.

Bw—16 to 25 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure; slightly hard, very friable; common very fine roots; neutral; clear wavy boundary.

C1—25 to 41 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, very friable; few very fine roots; neutral; clear wavy boundary.

C2—41 to 49 inches; light brownish gray (2.5Y 6/2) sandy clay loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, very friable; few very fine roots; about 10 percent small pebbles; slight effervescence; mildly alkaline; clear wavy boundary.

C3—49 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, very friable; about 10 percent small pebbles; slight effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 20 to 35 inches. The depth to carbonates ranges from 0 to 40 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is loam, silt loam, or silty clay loam. The Bw horizon has hue of 10YR or 2.5Y, value of 3 to 5 (2 or 3 moist), and chroma of 1 to 3. It is loam, silt loam, or silty clay loam. Some pedons have a buried A horizon. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (3 to 5 moist), and chroma of 1 to 3. It is loam, silt loam, or silty clay loam in the upper part and is stratified fine sandy loam to silty clay loam in the lower part.

Letcher Series

The Letcher series consists of deep, somewhat poorly drained and moderately well drained soils formed in glaciofluvial sediments on outwash plains. Permeability is slow in the subsoil and moderate or moderately rapid in the underlying material. Slopes range from 0 to 3 percent.

Typical pedon of Letcher fine sandy loam, in an area of Letcher-Embden-Miranda complex; 1,200 feet east and 600 feet south of the northwest corner of sec. 5, T. 126 N., R. 65 W.

A—0 to 8 inches; dark gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak fine granular structure; soft, very friable; common fine and very fine roots; strongly acid; clear wavy boundary.

E—8 to 13 inches; light brownish gray (10YR 6/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; weak coarse subangular blocky structure; soft, very friable; common fine and very fine roots; neutral; abrupt smooth boundary.

Bt1—13 to 17 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; strong coarse columnar structure; very hard, friable; few very fine roots; thin continuous gray (10YR 6/1)

coatings on the top of columns; slight effervescence; strongly alkaline; clear wavy boundary.

Bt2—17 to 27 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard, very friable; few very fine roots; slight effervescence; strongly alkaline; abrupt smooth boundary.

Ab—27 to 34 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak coarse and medium subangular blocky structure; slightly hard, friable; few very fine roots; strong effervescence; strongly alkaline; clear wavy boundary.

Bkzb—34 to 45 inches; brown (10YR 5/3) and light gray (10YR 7/1) loam, dark brown (10YR 3/3) and light brownish gray (10YR 6/2) moist; weak coarse and medium subangular blocky structure; slightly hard, friable; many fine accumulations of carbonate; common fine nests of salt; violent effervescence; strongly alkaline; clear wavy boundary.

C—45 to 60 inches; light brownish gray (10YR 6/2) sandy loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable; violent effervescence; strongly alkaline.

The surface soil is 5 to 20 inches thick. The depth to free carbonates ranges from 10 to 25 inches. Some pedons have glacial till between depths of 40 and 60 inches.

The A horizon has value of 4 or 5 (2 or 3 moist). It is loam, fine sandy loam, or sandy loam. The E horizon has value of 6 or 7 (3 to 5 moist) and chroma of 1 or 2. It is loamy fine sand, fine sandy loam, or sandy loam. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5 (3 or 4 moist), and chroma of 2 or 3. It is sandy loam or fine sandy loam. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 7 (3 to 6 moist), and chroma of 1 to 4. It is sandy loam or loamy fine sand.

Ludden Series

The Ludden series consists of deep, poorly drained and very poorly drained soils formed in clayey alluvium on flood plains. Permeability is slow. Slopes are less than 1 percent.

Typical pedon of Ludden silty clay, 360 feet south and 215 feet west of the northeast corner of sec. 4, T. 128 N., R. 61 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; weak medium subangular blocky structure parting to moderate very fine angular blocky and moderate fine granular; slightly hard, firm, sticky and plastic; common fine roots; few fine nests of gypsum; strong effervescence; mildly alkaline; abrupt smooth boundary.

Bw1—8 to 18 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; moderate medium subangular blocky structure parting to moderate fine and very fine angular blocky; slightly hard, firm, sticky and plastic; common fine roots; few fine nests of gypsum; strong effervescence; mildly alkaline; clear wavy boundary.

Bw2—18 to 37 inches; dark gray (N 4/0) silty clay, black (10YR 2/1) moist; weak coarse subangular blocky structure parting to moderate very fine angular blocky; slightly hard, firm, sticky and plastic; few fine roots; few fine nests of gypsum; slight effervescence; mildly alkaline; gradual wavy boundary.

Cg1—37 to 48 inches; gray (5Y 5/1) silty clay, dark gray (5Y 4/1) moist; common fine distinct light yellowish brown (2.5Y 6/4) mottles; massive; very hard, firm, sticky and plastic; few fine accumulations of carbonate; few fine nests of salt; common fine nests of gypsum; strong effervescence; moderately alkaline; clear wavy boundary.

Cg2—48 to 60 inches; gray (5Y 5/1) clay loam, dark gray (5Y 4/1) moist; common fine distinct light yellowish brown (2.5Y 6/4) mottles; massive; very hard, firm, slightly sticky and slightly plastic; few large and medium accumulations of carbonate; few fine nests of salt; common medium and fine nests of gypsum; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 24 to 48 inches in thickness and includes the Bw horizon. The A horizon has hue of 10YR or 2.5Y and value of 3 to 5 (2 or 3 moist). It is clay or silty clay. The Bw horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 3 to 5 (2 to 4 moist) and chroma of 0 to 2. It is silty clay or clay. The Cg horizon has hue of 2.5Y or 5Y or is neutral in hue. It has value of 3 to 5 (2 to 4 moist) and chroma of 0 to 2. It is clay, silty clay, or clay loam.

Maddock Series

The Maddock series consists of deep, well drained soils formed in sandy sediments on glacial lake plains. Permeability is rapid in the subsoil and moderate in the underlying material. Slopes range from 1 to 8 percent.

Typical pedon of Maddock loamy fine sand, in an area of Maddock-Hecla-Hamar loamy fine sands, 2 to 8 percent slopes; 2,060 feet south and 650 feet west of the northeast corner of sec. 7, T. 126 N., R. 60 W.

A1—0 to 6 inches; dark gray (10YR 4/1) loamy fine sand, black (10YR 2/1) moist; weak very fine granular structure; soft, very friable; common fine and many very fine roots; slightly acid; clear wavy boundary.

A2—6 to 13 inches; dark gray (10YR 4/1) loamy fine sand, black (10YR 2/1) moist; weak very fine granular structure; soft, very friable; common fine and many very fine roots; slightly acid; gradual wavy boundary.

C1—13 to 21 inches; grayish brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; single grain; loose; common very fine roots; slightly acid; gradual wavy boundary.

C2—21 to 42 inches; grayish brown (2.5Y 5/2) loamy fine sand, dark grayish brown (2.5Y 4/2) moist; single grain; loose; common very fine roots; slightly acid; gradual wavy boundary.

Akb—42 to 48 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, friable; violent effervescence; neutral; clear wavy boundary.

C′—48 to 60 inches; light brownish gray (2.5Y 6/2) fine sandy loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, friable; strong effervescence; mildly alkaline.

The mollic epipedon ranges from 10 to 16 inches in thickness. The depth to free carbonates ranges from 10 to more than 60 inches.

The A horizon has value of 3 to 5 (2 or 3 moist). It is loamy fine sand, fine sandy loam, sandy loam, fine sand, or loamy sand. The C horizon has value of 4 to 7 (3 to 6 moist) and chroma of 2 to 4. It is loamy sand, loamy fine sand, or fine sand. Some pedons do not have a buried horizon. The texture ranges from sand to clay loam below a depth of 40 inches.

Miranda Series

The Miranda series consists of deep, moderately well drained and somewhat poorly drained soils formed in glacial till on till plains. Permeability is very slow. Slopes range from 0 to 2 percent.

Typical pedon of Miranda loam, in an area of Noonan-Niobell-Miranda loams; 660 feet south and 235 feet west of the northeast corner of sec. 19, T. 125 N., R. 65 W.

E—0 to 4 inches; gray (10YR 5/1) loam, very dark gray (10YR 3/1) moist; moderate thin platy structure; slightly hard, very friable; many fine and very fine roots; slightly acid; abrupt smooth boundary.

Bt1—4 to 7 inches; grayish brown (10YR 5/2) clay loam, black (10YR 2/1) moist; strong coarse and medium columnar structure parting to moderate medium angular blocky; very hard, firm, sticky and plastic; common fine and very fine roots; thin continuous gray (10YR 6/1) coatings on the top of columns; gray (10YR 6/1) sand grains on sides of columns; continuous shiny films on vertical faces of peds; neutral; clear wavy boundary.

Bt2—7 to 11 inches; dark grayish brown (10YR 4/2) clay loam, black (10YR 2/1) moist; moderate medium prismatic structure parting to moderate medium angular blocky; hard, firm, sticky and plastic; common fine and very fine roots; continuous shiny films on vertical faces of peds; mildly alkaline; clear wavy boundary.

Btz—11 to 23 inches; light olive brown (2.5Y 5/4) clay loam, olive brown (2.5Y 4/4) moist; weak medium prismatic structure parting to weak coarse and medium subangular blocky; hard, firm, sticky and plastic; few very fine roots; discontinuous shiny films on vertical faces of peds; common fine nests of gypsum; common fine nests and threads of salt; moderately alkaline; clear wavy boundary.

Bkz—23 to 29 inches; light yellowish brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) moist; common fine faint yellowish brown (10YR 5/4) mottles; weak coarse subangular blocky structure; very hard, firm, sticky and plastic; few very fine roots; common light olive brown (2.5Y 5/4) tongues, olive brown (2.5Y 4/4) moist; common fine accumulations of carbonate; many medium and fine nests and seams of gypsum; few fine threads of salt; strong effervescence; strongly alkaline; clear wavy boundary.

C1—29 to 38 inches; light brownish gray (2.5Y 6/2) clay loam, olive brown (2.5Y 4/4) moist; common medium and fine distinct yellowish brown (10YR 5/6) and light gray (10YR 7/1) mottles; massive; very hard, firm, sticky and plastic; common medium and fine accumulations of carbonate; common fine threads of gypsum; few fine threads of salt; strong effervescence; strongly alkaline; gradual wavy boundary.

C2—38 to 60 inches; light yellowish brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) moist; common medium and fine distinct yellowish brown (10YR 5/6) and light gray (10YR 7/1) mottles; massive; very hard, firm, sticky and plastic; few fine dark stains (manganese oxide); common medium and fine accumulations of carbonate; few fine nests of gypsum; few fine threads of salt; few small pebbles; strong effervescence; strongly alkaline.

The thickness of the E horizon is 1 to 5 inches. The

depth to free carbonates ranges from 8 to 25 inches. The depth to accumulations of gypsum and salt ranges from 6 to 16 inches. Some pedons have an A horizon, which is 1 to 3 inches thick. The thickness of the A horizon combined with that of the E horizon is less than 6 inches.

The E horizon has value of 5 to 7 (3 or 4 moist) and chroma of 1 or 2. It is loam or silt loam. The Bt horizon has value of 3 to 6 (2 to 4 moist) and chroma of 1 to 4. It is clay loam or loam. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 8 (4 to 6 moist), and chroma of 2 to 4. It is clay loam or loam.

Nahon Series

The Nahon series consists of deep, moderately well drained and somewhat poorly drained soils formed in clayey glaciolacustrine sediments on glacial lake plains. Permeability is very slow in the subsoil and moderately slow or very slow in the underlying material. Slopes are less than 2 percent.

Typical pedon of Nahon silty clay loam (fig. 14), in an area of Aberdeen-Nahon silty clay loams; 1,163 feet south and 259 feet west of the northeast corner of sec. 9, T. 122 N., R. 63 W.

Ap—0 to 6 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; slightly acid; abrupt smooth boundary.

E—6 to 9 inches; gray (10YR 6/1 and 5/1) silt loam, dark grayish brown (10YR 4/2) and very dark gray (10YR 3/1) moist; weak medium platy structure; slightly hard, friable; neutral; abrupt smooth boundary.

Bt1—9 to 14 inches; gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; weak medium and fine columnar structure parting to moderate fine blocky; very hard, firm, sticky and plastic; thin continuous gray (10YR 6/1) coatings on the top of columns; thin continuous shiny films on vertical faces of peds; mildly alkaline; clear wavy boundary.

Bt2—14 to 20 inches; grayish brown (10YR 5/2) silty clay loam, very dark gray (10YR 3/1) moist; moderate medium and fine prismatic structure parting to moderate medium blocky; hard, firm, sticky and plastic; thin continuous shiny films on vertical faces of peds; few fine nests of salt in the lower part; moderately alkaline; clear wavy boundary.

Bz—20 to 25 inches; light brownish gray (2.5Y 6/2) and pale yellow (2.5Y 7/4) silty clay loam, dark grayish brown (2.5Y 4/2) and light olive brown (2.5Y 5/4) moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, firm, sticky and plastic; few fine accumulations of carbonate; common fine nests of gypsum and other salts; slight effervescence; mildly alkaline; clear wavy boundary.

Bkz—25 to 37 inches; pale yellow (2.5Y 7/4) silty clay loam, light olive brown (2.5Y 5/4) moist; weak coarse subangular blocky structure; slightly hard,

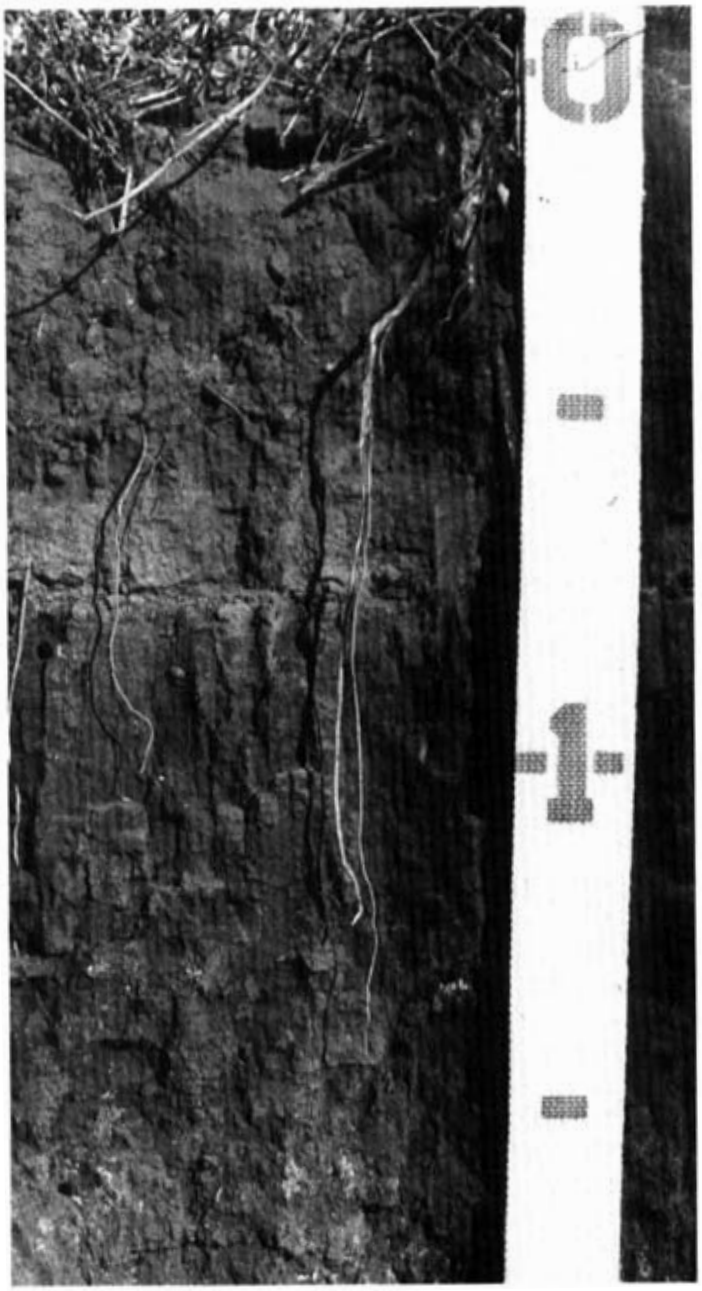

Figure 14.—Profile of a Nahon silty clay loam. Columnar structure is at a depth of about 9 inches. Depth is marked in feet.

friable, slightly sticky and slightly plastic; common fine nests of gypsum and other salts; violent effervescence (21 percent calcium carbonate); moderately alkaline; clear wavy boundary.

C1—37 to 56 inches; white (2.5Y 8/2) and grayish brown (2.5Y 5/2) silty clay loam that has varves of very fine sandy loam and silty clay 1 to 3 millimeters thick; pale yellow (2.5Y 7/4) and dark grayish brown (2.5Y 4/2) moist; massive; hard, friable; violent effervescence; moderately alkaline; gradual wavy boundary.

C2—56 to 60 inches; white (2.5Y 8/2) and grayish brown (2.5Y 5/2) clay that has varves of very fine sandy loam and silty clay 5 to 10 millimeters thick; pale yellow (2.5Y 7/4) and dark grayish brown (2.5Y 4/2) moist; massive; hard, firm; strong effervescence; moderately alkaline.

The surface soil is 6 to 17 inches thick. The depth to free carbonates ranges from 14 to 32 inches. The depth to accumulations of gypsum and other salts is more than 16 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is silt loam or silty clay loam. The E horizon is silt loam or silty clay loam. Some pedons that have an Ap horizon do not have an E horizon. The Bt horizon has value of 3 to 5 (2 or 3 moist) and chroma of 1 to 3. In some pedons it does not have gypsum or other salts in the lower part. Some pedons have a Btz horizon. The C horizon has hue of 2.5Y or 5Y, value of 6 to 8 (4 to 7 moist), and chroma of 2 to 4. It is silty clay loam, clay, or silty clay. It is varved with very fine sand to clay in the lower part. The varves range from 1 to 10 millimeters in thickness. Some pedons have fine sand below a depth of 40 inches.

Niobell Series

The Niobell series consists of deep, moderately well drained soils formed in glacial till on till plains. Permeability is slow. Slopes range from 0 to 6 percent.

The Niobell soils in this county have lower chroma in the A horizon than is definitive for the series. This difference, however, does not alter the use or behavior of the soils.

Typical pedon of Niobell loam, in an area of Noonan-Niobell-Miranda loams; 645 feet south and 250 feet west of the northeast corner of sec. 19, T. 125 N., R. 65 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) loam, black (10YR 2/1) moist; weak medium and fine subangular blocky structure parting to moderate fine granular; slightly hard, very friable; many fine and very fine roots; slightly acid; clear wavy boundary.

E—8 to 10 inches; grayish brown (10YR 5/2) loam, very dark gray (10YR 3/1) moist; weak thin platy structure parting to weak fine granular; slightly hard, very friable; many fine and very fine roots; slightly acid; abrupt wavy boundary.

BE—10 to 16 inches; dark grayish brown (10YR 4/2) clay loam, very dark gray (10YR 3/1) moist; light brownish gray (10YR 6/2) silt coatings on faces of peds; weak medium prismatic structure parting to weak fine angular blocky; hard, friable, sticky and plastic; many fine and very fine roots; slightly acid; clear wavy boundary.

Bt1—16 to 23 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to strong medium and fine angular blocky; hard, friable, sticky and plastic; common fine and very fine roots; continuous shiny films on vertical faces of peds; slightly acid; clear wavy boundary.

Bt2—23 to 28 inches; yellowish brown (10YR 5/4) clay loam, olive brown (2.5Y 4/4) moist; moderate medium prismatic structure parting to strong medium and fine angular blocky; hard, friable, sticky and plastic; common fine and very fine roots; continuous shiny films on vertical faces of peds; neutral; clear wavy boundary.

Bt3—28 to 34 inches; light yellowish brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) moist; few fine faint dark yellowish brown (10YR 3/6) mottles; weak medium prismatic structure parting to moderate coarse and medium subangular blocky; hard, friable, sticky and plastic; few very fine roots; discontinuous shiny films on vertical faces of peds; slight effervescence; mildly alkaline; clear wavy boundary.

Bk—34 to 46 inches; light yellowish brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) moist; common fine faint dark yellowish brown (10YR 3/6) mottles; moderate medium subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; few fine accumulations of carbonate; few fine nests of gypsum and other salts; strong effervescence; moderately alkaline; gradual wavy boundary.

C—46 to 60 inches; pale yellow (2.5Y 7/4) clay loam, light olive brown (2.5Y 5/4) moist; common medium and fine faint yellowish brown (10YR 5/8) mottles; massive; hard, friable, sticky and plastic; few fine accumulations of carbonate; strong effervescence; moderately alkaline.

The surface soil is 5 to 15 inches thick. The depth to free carbonates ranges from 16 to 29 inches.

The A horizon has value of 4 or 5 (2 or 3 moist). It is

loam or silt loam. The E horizon has value of 4 to 7 (3 to 5 moist). It is loam or silt loam. Some pedons do not have an E horizon. The Bt horizon has value of 4 to 6 and chroma of 2 to 4. It is clay loam or loam. The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is loam or clay loam.

Nishon Series

The Nishon series consists of deep, poorly drained soils formed in local alluvium on till plains. Permeability is slow. Slopes are less than 1 percent.

The Nishon soils in this county have a darker A horizon than is definitive for the series. This difference, however, does not alter the use or behavior of the soils.

Typical pedon of Nishon silt loam, in an area of Tonka-Nishon silt loams; 745 feet east and 418 feet south of the northwest corner of sec. 30, T. 123 N., R. 64 W.

A—0 to 4 inches; dark grayish brown (10YR 4/2) silt loam, black (10YR 2/1) moist; weak thin platy structure; slightly hard, very friable; slightly acid; clear smooth boundary.

E—4 to 8 inches; light gray (10YR 7/1) silt loam, dark grayish brown (10YR 4/2) moist; common medium and fine distinct dark yellowish brown (10YR 4/4) mottles; moderate thin platy structure; slightly hard, friable; slightly acid; abrupt smooth boundary.

Bt1—8 to 12 inches; gray (10YR 5/1) clay, very dark gray (10YR 3/1) moist; strong coarse and medium columnar structure parting to strong coarse and medium blocky; very hard, very firm, sticky and plastic; thin continuous light gray (10YR 7/1) coatings on the top of columns; discontinuous shiny films on vertical faces of peds; moderately alkaline; clear wavy boundary.

Bt2—12 to 22 inches; gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; strong medium prismatic structure parting to strong coarse and medium subangular blocky; very hard, firm, sticky and plastic; discontinuous shiny films on vertical faces of peds; moderately alkaline; clear wavy boundary.

Bk—22 to 32 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak medium and fine subangular blocky; hard, firm, sticky and plastic; few fine concretions of manganese oxide; common coarse and medium accumulations of carbonate; strong effervescence; strongly alkaline; gradual wavy boundary.

C1—32 to 53 inches; light gray (2.5Y 7/2) silty clay, light brownish gray (2.5Y 6/2) moist; many medium and fine distinct yellowish brown (10YR 5/6) mottles; massive; hard, friable; common medium and fine distinct strong brown (7.5YR 5/6) iron stains; common medium and fine concretions of manganese oxide; common medium and fine accumulations of carbonate; strong effervescence; strongly alkaline; gradual wavy boundary.

C2—53 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; many medium and fine distinct yellowish brown (10YR 5/6) mottles; massive; hard, friable; common medium and fine strong brown (7.5YR 5/6) iron stains; common medium and fine concretions of manganese oxide; common medium and fine accumulations of carbonate; strong effervescence; strongly alkaline.

The surface soil is 4 to 8 inches thick. The depth to carbonates ranges from 15 to 34 inches.

The A horizon has value of 4 or 5 (2 or 3 moist). It is silt loam or loam. The E horizon has value of 5 to 7 (4 or 5 moist). It is silt loam or loam. The Bt horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 4 or 5 (3 or 4 moist) and chroma of 0 or 1. It is silty clay or clay. The C horizon has hue of 2.5Y or 5Y, value of 4 to 7 (3 to 6 moist), and chroma of 1 to 3. It is silty clay, clay loam, or clay.

Noonan Series

The Noonan series consists of deep, moderately well drained soils formed in glacial till on till plains. Permeability is slow. Slopes range from 0 to 4 percent.

The Noonan soils in this county have lower chroma in the A horizon than is definitive for the series. This difference, however, does not alter the use or behavior of the soils.

Typical pedon of Noonan loam, in an area of Noonan-Niobell-Miranda loams; 624 feet south and 245 feet west of the northeast corner of sec. 19, T. 125 N., R. 65 W.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) loam, black (10YR 2/1) moist; moderate medium and fine granular and weak coarse and medium subangular blocky structure; slightly hard, very friable; many fine and very fine roots; slightly acid; abrupt smooth boundary.

E—7 to 9 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium platy structure; slightly hard, very friable; many fine

and very fine roots; neutral; abrupt smooth boundary.

Bt1—9 to 12 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; strong coarse and medium columnar structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; few very fine roots; thin continuous gray (10YR 6/1) coatings on the top of columns; discontinuous shiny films on vertical faces of peds; mildly alkaline; clear wavy boundary.

Bt2—12 to 18 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; few very fine roots; discontinuous shiny films on vertical faces of peds; moderately alkaline; clear wavy boundary.

Bz—18 to 26 inches; light olive brown (2.5Y 5/4) clay loam, olive brown (2.5Y 4/4) moist; common medium and fine faint dark yellowish brown (10YR 4/4 and 4/6) mottles; weak medium subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; discontinuous shiny films on vertical faces of peds; common medium and fine nests of gypsum; common fine nests and seams of salt; moderately alkaline; clear wavy boundary.

Bk—26 to 54 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; many coarse and medium distinct dark yellowish brown (10YR 4/6) and yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; hard, friable, sticky and plastic; few very fine roots to a depth of 40 inches; common medium accumulations of carbonate; violent effervescence; strongly alkaline; clear wavy boundary.

C—54 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; many coarse and medium distinct yellowish brown (10YR 5/4) mottles; massive; hard, friable, sticky and plastic; few fine accumulations of carbonate; strong effervescence; strongly alkaline.

The surface soil is 6 to 14 inches thick. The depth to free carbonates ranges from 15 to 35 inches. Salts are in the lower part of the Bt horizon in some pedons.

The Ap horizon has value of 4 or 5 (2 or 3 moist). It is loam or silt loam. The E horizon has value of 5 to 7 (3 to 5 moist) and chroma of 1 or 2. It is loam, silt loam, or very fine sandy loam. The Bt horizon has hue of 10YR or 2.5Y, value of 4 to 6 (3 or 4 moist), and chroma of 2 or 3. The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is loam or clay loam.

Parnell Series

The Parnell series consists of deep, very poorly drained soils formed in clayey alluvium on till plains. Permeability is slow. Slopes are less than 1 percent.

Typical pedon of Parnell silty clay loam, 2,535 feet east and 300 feet north of the southwest corner of sec. 19, T. 128 N., R. 62 W.

A—0 to 8 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; moderate fine and very fine subangular blocky structure; hard, friable; many fine and very fine roots; slightly acid; clear wavy boundary.

Bt1—8 to 18 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; moderate fine and very fine angular blocky structure; hard, firm, sticky and plastic; common very fine roots; discontinuous shiny films on vertical faces of peds; neutral; clear wavy boundary.

Bt2—18 to 32 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; moderate medium subangular blocky structure parting to moderate fine and very fine angular blocky; hard, firm, sticky and plastic; few very fine roots; discontinuous shiny films on vertical faces of peds; neutral; clear wavy boundary.

Bt3—32 to 44 inches; gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; common fine distinct dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure parting to moderate fine and very fine angular blocky; hard, firm, sticky and plastic; discontinuous shiny films on vertical faces of peds; neutral; clear wavy boundary.

Bk—44 to 54 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium and fine subangular blocky structure; very hard, firm, sticky and plastic; few fine accumulations of carbonate; few fine nests of salt; strong effervescence; mildly alkaline; clear wavy boundary.

Cg—54 to 60 inches; light olive gray (5Y 6/2) silty clay loam, olive gray (5Y 5/2) moist; common medium and fine distinct yellowish brown (10YR 5/6) and brownish yellow (10YR 6/6) mottles; massive; very hard, friable; few fine accumulations of carbonate; few fine nests of salt; slight effervescence; mildly alkaline.

The mollic epipedon ranges from 24 to more than 60 inches thick. The depth to free carbonates ranges from 35 to more than 60 inches. Some pedons have an O horizon, which is as much as 3 inches thick.

The A horizon has hue of 10YR, 2.5Y, or 5Y and value of 4 or 5 (2 or 3 moist). It is silty clay loam, silt loam, or silty clay. The Bt horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6 (2 to 4 moist), and chroma of 1 or 2. It is silty clay, silty clay loam, clay, or clay loam. The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (3 to 6 moist), and chroma of 1 or 2. It is clay, silty clay, clay loam, silty clay loam, or loam.

Peever Series

The Peever series consists of deep, well drained soils formed in fine textured glacial till on till plains. Permeability is moderately slow or slow. Slopes range from 0 to 6 percent.

Typical pedon of Peever clay loam, in an area of Peever-Buse clay loams, 1 to 4 percent slopes; 500 feet east and 180 feet north of the southwest corner of sec. 25, T. 121 N., R. 60 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) clay loam, black (10YR 2/1) moist; moderate fine granular structure; hard, friable; common fine and very fine roots; neutral; abrupt smooth boundary.

Bt—7 to 14 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate medium and fine angular blocky; very hard, firm, sticky and plastic; few fine and very fine roots; continuous shiny films on vertical faces of peds; common very dark gray (10YR 3/1) tongues, black (10YR 2/1) moist; neutral; clear wavy boundary.

Btk—14 to 26 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate coarse and medium prismatic structure parting to moderate coarse and medium subangular blocky; very hard, firm, sticky and plastic; few very fine roots; common medium and fine accumulations of carbonate; strong effervescence; moderately alkaline; clear wavy boundary.

Bk1—26 to 34 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure parting to moderate coarse and medium subangular blocky; hard, firm, sticky and plastic; few fine strong brown (7.5YR 5/6) iron stains; common fine accumulations of carbonate; strong effervescence; moderately alkaline; clear wavy boundary.

Bk2—34 to 43 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; common medium and fine distinct yellowish brown (10YR 5/6 and 5/8) and few fine distinct gray (10YR 5/1) mottles; moderate coarse and medium subangular blocky structure; hard, firm, sticky and plastic; few fine strong brown (7.5YR 5/6) iron stains; common fine accumulations of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

C—43 to 60 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; common medium and fine distinct yellowish brown (10YR 5/6 and 5/8) and few fine distinct gray (10YR 5/1) mottles; massive; hard, firm, sticky and plastic; common medium and fine dark stains (manganese oxide); common medium and fine strong brown (7.5YR 5/6) iron stains; few fine accumulations of carbonate; few medium and fine nests of gypsum; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The depth to free carbonates ranges from 13 to 26 inches.

The Ap horizon has value of 3 or 4 (2 or 3 moist). It is clay loam or silty clay loam. It is 6 to 10 inches thick. The Bt horizon has value of 4 to 6 (2 to 4 moist) and chroma of 1 to 3. It is clay, silty clay, or clay loam. The C horizon has value of 5 to 7 (4 to 6 moist) and chroma of 2 to 4. It is clay loam or clay.

Playmoor Series

The Playmoor series consists of deep, poorly drained, saline soils formed in alluvium on flood plains. Permeability is moderate or moderately slow. Slopes are less than 2 percent.

Typical pedon of Playmoor silty clay loam, 336 feet east and 292 feet north of the southwest corner of sec. 14, T. 123 N., R. 62 W.

Az1—0 to 4 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak medium granular structure; hard, friable; many very fine roots; common fine nests and threads of salt; strong effervescence; mildly alkaline; clear wavy boundary.

Az2—4 to 10 inches; gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; weak medium subangular blocky structure parting to weak medium granular; hard, friable; common very fine roots; few coarse accumulations of carbonate; common fine nests and threads of salt; strong effervescence; mildly alkaline; clear wavy boundary.

Bz1—10 to 20 inches; gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; weak coarse and medium subangular blocky structure; hard, friable; common very fine roots; few coarse accumulations of carbonate; few fine nests of gypsum; common fine nests of salt; strong effervescence; moderately

alkaline; clear wavy boundary.

Bz2—20 to 25 inches; gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; weak medium and fine subangular blocky structure; hard, friable; few very fine roots; few coarse accumulations of carbonate; common medium and fine nests of gypsum; common fine nests of salt; strong effervescence; moderately alkaline; clear wavy boundary.

Bz3—25 to 34 inches; gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; weak medium and fine subangular blocky structure; hard, friable; few very fine roots; common medium accumulations of carbonate; common fine nests of gypsum; common fine nests of salt; strong effervescence; moderately alkaline; clear wavy boundary.

Bg—34 to 49 inches; gray (5Y 5/1) silty clay loam, dark gray (5Y 4/1) moist; weak medium and fine subangular blocky structure; hard, friable; few coarse and common medium and fine accumulations of carbonate; common fine nests of gypsum; strong effervescence; moderately alkaline; clear wavy boundary.

Cg1—49 to 56 inches; gray (5Y 6/1) sandy loam, dark gray (5Y 4/1) moist; few fine distinct yellowish brown (10YR 5/6) mottles; massive; hard, friable; strong effervescence; moderately alkaline; clear smooth boundary.

Cg2—56 to 60 inches; light gray (5Y 7/2) loamy sand, olive gray (5Y 4/2) moist; common fine distinct yellowish brown (10YR 5/6) mottles; massive; hard, friable; slight effervescence; moderately alkaline.

The mollic epipedon is 24 to 45 inches thick. The soils are calcareous throughout and have few to many fine accumulations of salt. Some pedons have a buried A horizon.

The A horizon typically is silty clay loam but is silt loam in some pedons. The Bz horizon has hue of 10YR, 2.5Y, or 5Y and value of 4 to 7. It is silty clay loam or silt loam. The Bg horizon has hue of 2.5Y or 5Y and value of 4 to 7. It is silty clay loam or silt loam. The Cg horizon has hue of 2.5Y or 5Y or is neutral in hue. It has value of 5 to 7 (3 or 4 moist) and chroma of 0 to 2. It typically is silty clay loam or silt loam, but some pedons have strata of sand, silt, or clay below a depth of 40 inches.

Putney Series

The Putney series consists of deep, well drained soils formed in silty glaciolacustrine sediments on glacial lake plains. Permeability is moderate in the subsoil and moderate to slow in the underlying material. Slopes range from 0 to 6 percent.

Typical pedon of Putney silt loam, in an area of Great Bend-Putney silt loams, 0 to 2 percent slopes; 1,660 feet north and 175 feet east of the southwest corner of sec. 27, T. 124 N., R. 61 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, very friable; common fine roots; neutral; abrupt smooth boundary.

Bw—8 to 15 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; hard, friable, slightly sticky and slightly plastic; common fine roots; mildly alkaline; abrupt wavy boundary.

Bkz1—15 to 20 inches; light gray (2.5Y 7/2) silty clay loam, light yellowish brown (2.5Y 6/4) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; common fine pores; common fine nests and threads of salt; violent effervescence (35 percent calcium carbonate); moderately alkaline; clear wavy boundary.

Bkz2—20 to 25 inches; light gray (2.5Y 7/2) silt loam, light yellowish brown (2.5Y 6/4) moist; weak coarse subangular blocky structure; slightly hard, friable; few fine pores; common medium and many fine nests of gypsum; violent effervescence (12 percent calcium carbonate); moderately alkaline; clear wavy boundary.

C1—25 to 40 inches; pale yellow (2.5Y 7/4) silt loam, olive brown (2.5Y 4/4) moist; massive; slightly hard, very friable; strong effervescence; moderately alkaline; clear smooth boundary.

C2—40 to 60 inches; pale yellow (2.5Y 7/4) silt loam, light yellowish brown (2.5Y 6/4) moist; few fine distinct yellowish brown (10YR 5/6) mottles; massive; slightly hard, very friable; varves 1 to 2 millimeters thick; few fine nests of gypsum and other salts; slight effervescence; moderately alkaline.

The depth to free carbonates ranges from 10 to 20 inches. The depth to visible crystals of salt is less than 20 inches. The greatest accumulations of salts other than gypsum typically are in the Bk horizon between depths of 11 and 20 inches. Accumulations of gypsum typically are at a depth of 14 to 30 inches.

The A horizon has value of 4 or 5 (2 or 3 moist). It is silt loam or silty clay loam. The Bw horizon has hue of 10YR or 2.5Y, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is silty clay loam or silt loam. The C

horizon has hue of 10YR or 2.5Y, value of 6 to 8 (4 to 6 moist), and chroma of 1 to 4. It is silt loam or silty clay loam and typically is varved with very fine sand to clay in the lower part.

Ranslo Series

The Ranslo series consists of deep, somewhat poorly drained soils formed in clayey alluvium on flood plains. Permeability is slow. Slopes are 0 to 1 percent.

Typical pedon of Ranslo loam, in an area of Ranslo-Harriet loams; 1,900 feet west and 75 feet north of the southeast corner of sec. 8, T. 126 N., R. 65 W.

A—0 to 7 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, friable; many fine and very fine roots; neutral; clear wavy boundary.

E—7 to 10 inches; gray (10YR 5/1) loam, very dark gray (10YR 3/1) moist; weak medium subangular blocky structure; slightly hard, friable; many fine and very fine roots; neutral; abrupt smooth boundary.

Bt—10 to 15 inches; dark gray (10YR 4/1) clay loam, very dark gray (10YR 3/1) moist; moderate medium columnar structure parting to strong medium blocky; very hard, firm, sticky and plastic; common fine and very fine roots; thin continuous gray (10YR 5/1) coatings on the top of columns; continuous shiny films on vertical faces of peds; moderately alkaline; clear wavy boundary.

Btkz—15 to 24 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; few fine faint yellowish brown (10YR 5/6) and gray (10YR 5/1) mottles; moderate medium prismatic structure parting to strong medium blocky; very hard, firm, sticky and plastic; few fine and very fine roots; few coarse accumulations of carbonate; common medium and fine nests of gypsum and other salts; violent effervescence; strongly alkaline; gradual wavy boundary.

Bk—24 to 32 inches; light olive gray (5Y 6/2) clay loam, olive (5Y 5/3) moist; common fine faint yellowish brown (10YR 5/6) mottles; moderate medium blocky structure; hard, firm, sticky and plastic; few fine and very fine roots; common fine strong brown (7.5YR 5/6) iron stains; few coarse and many medium and fine accumulations of carbonate; violent effervescence; moderately alkaline; gradual wavy boundary.

C—32 to 60 inches; light olive gray (5Y 6/2) clay loam, olive (5Y 5/3) moist; many fine faint yellowish brown (10YR 5/6) and dark gray (10YR 4/1) mottles; massive; hard, firm, sticky and plastic; common fine strong brown (7.5YR 5/6) iron stains; few fine dark stains (manganese oxide); few coarse and common fine accumulations of carbonate; 30 to 40 percent shale chips; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 10 to 35 inches. The surface soil is 2 to 16 inches thick.

The A horizon has value of 4 or 5 (2 or 3 moist). It is loam, silty clay loam, or silt loam. The E horizon has value of 5 or 6 (2 to 4 moist) and chroma of 1 or 2. It is loam or silt loam. Some pedons have a B/E horizon. The Bt horizon has hue of 10YR or 2.5Y and value of 3 to 5 (2 or 3 moist). It is clay loam, silty clay loam, or silty clay. The Btkz horizon has hue of 10YR or 2.5Y, value of 4 to 7 (3 to 5 moist), and chroma of 1 or 2. It is silty clay loam, clay loam, silty clay, or clay. The Bk horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 7 (3 to 6 moist), and chroma of 1 to 3. It is clay loam, silty clay loam, silty clay, or clay. Some pedons have a Bkz horizon. The C horizon has hue of 2.5Y or 5Y, value of 4 to 7 (3 to 6 moist), and chroma of 1 to 4. It is sandy clay loam, clay loam, silty clay loam, silty clay, or clay.

Renshaw Series

The Renshaw series consists of deep, somewhat excessively drained soils formed in loamy sediments that are shallow over gravelly sand. These soils are on outwash plains and terraces. Permeability is moderate or moderately rapid in the loamy sediments and rapid or very rapid in the underlying gravelly sand. Slopes range from 0 to 6 percent.

Typical pedon of Renshaw loam, in an area of Renshaw-Fordville loams, 0 to 2 percent slopes; 2,550 feet west and 1,640 feet south of the northeast corner of sec. 21, T. 124 N., R. 63 W.

Ap—0 to 6 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, very friable; common fine and very fine roots; neutral; abrupt smooth boundary.

Bw—6 to 15 inches; dark grayish brown (10YR 4/2) sandy clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable; common fine and very fine roots; neutral; abrupt smooth boundary.

2C1—15 to 32 inches; light brownish gray (10YR 6/2) gravelly coarse sand, dark grayish brown (10YR 4/2) moist; single grain; loose; few fine and very fine roots; carbonates coating the undersides of pebbles; slight effervescence; mildly alkaline; gradual wavy boundary.

2C2—32 to 60 inches; very pale brown (10YR 7/3)

gravelly coarse sand, dark brown (10YR 3/3) moist; single grain; loose; strong effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 10 to 16 inches. The depth to gravelly sand is 14 to 20 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is loam, gravelly loam, or sandy loam. The Bw horizon has value of 3 to 5 (3 or 4 moist) and chroma of 1 to 4. It is loam, sandy loam, sandy clay loam, or gravelly loam. The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 7 (3 to 6 moist), and chroma of 2 to 4. It is gravelly loamy sand, gravelly sand, gravelly coarse sand, or coarse sand.

Rhoades Series

The Rhoades series consists of deep, moderately well drained soils formed in clayey alluvium derived from soft shales. These soils are on terraces. Permeability is very slow. Slopes range from 0 to 4 percent.

Typical pedon of Rhoades loam, in an area of Daglum-Rhoades loams, 0 to 4 percent slopes; 2,610 feet south and 105 feet west of the northeast corner of sec. 5, T. 124 N., R. 65 W.

E—0 to 2 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; very weak medium subangular blocky structure parting to very weak thin platy; slightly hard, very friable; many very fine roots; medium acid; abrupt smooth boundary.

Bt1—2 to 6 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; common fine distinct dark yellowish brown (10YR 4/6) mottles; moderate coarse and medium columnar structure parting to moderate coarse and medium angular blocky; very hard, firm, sticky and plastic; many very fine roots along the faces of peds; thin continuous gray (10YR 6/1) coatings on the top of columns and on faces of peds; mildly alkaline; clear smooth boundary.

Bt2—6 to 10 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate coarse and medium prismatic structure parting to moderate coarse and medium angular blocky; hard, firm, sticky and plastic; common very fine roots along the faces of peds; moderately alkaline; clear wavy boundary.

Bz—10 to 18 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate coarse and medium prismatic structure parting to moderate coarse and medium angular blocky; hard, firm, sticky and plastic; few fine accumulations of carbonate; common fine crystals of salt; moderately alkaline; gradual wavy boundary.

Bkz1—18 to 26 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate coarse and medium prismatic structure parting to weak medium subangular blocky; hard, firm, sticky and plastic; common fine accumulations of carbonate; few fine nests of salt; strong effervescence; strongly alkaline; gradual wavy boundary.

Bkz2—26 to 34 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak coarse and medium prismatic structure parting to weak coarse and medium subangular blocky; hard, firm, sticky and plastic; common fine accumulations of carbonate; few fine nests of salt; about 15 percent shale chips; strong effervescence; strongly alkaline; gradual wavy boundary.

C—34 to 46 inches; light olive gray (5Y 6/2) clay loam, olive gray (5Y 4/2) moist; massive; hard, firm, sticky and plastic; few medium accumulations of carbonate; few medium nests of salt; about 30 percent shale chips; slight effervescence; strongly alkaline; gradual wavy boundary.

Cr—46 to 60 inches; light olive gray (5Y 6/2) bedded shale, olive gray (5Y 4/2) moist; many fine strong brown (7.5YR 5/6) iron stains on surfaces of plates; moderately alkaline.

The thickness of the E horizon is 2 to 4 inches. The depth to bedded shale is more than 40 inches. Some pedons have a thin A horizon.

The E horizon has value of 4 to 6 (2 to 5 moist). It is loam, silt loam, fine sandy loam, silty clay loam, clay loam, or silty clay. The Bt horizon has hue of 10YR or 2.5Y and value of 3 to 5 (2 or 3 moist). It is silty clay loam, clay loam, clay, or silty clay. The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 or 5 moist), and chroma of 2 to 4. It is clay loam, loam, silty clay loam, silty clay, or clay.

Rondell Series

The Rondell series consists of deep, moderately well drained soils formed in silty glaciolacustrine sediments on glacial lake plains. Permeability is moderate in the subsoil and moderate to slow in the underlying material. Slopes range from 0 to 3 percent.

Typical pedon of Rondell silt loam, in an area of Beotia-Rondell silt loams, 0 to 3 percent slopes; 2,565

feet west and 150 feet north of the southeast corner of sec. 11, T. 126 N., R. 60 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak fine subangular blocky structure parting to weak fine granular; slightly hard, friable; slight effervescence (3 percent calcium carbonate); neutral; abrupt smooth boundary.

A—7 to 12 inches; dark gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; weak medium and fine subangular blocky structure; slightly hard, friable; few fine accumulations of carbonate; slight effervescence (4 percent calcium carbonate); neutral; clear wavy boundary.

Bk1—12 to 24 inches; white (2.5Y 8/2) silt loam, light brownish gray (2.5Y 6/2) moist; weak coarse subangular blocky structure parting to weak medium and fine subangular blocky; slightly hard, friable; violent effervescence (39 percent calcium carbonate); moderately alkaline; clear wavy boundary.

Bk2—24 to 35 inches; white (2.5Y 8/2) silt loam, light yellowish brown (2.5Y 6/4) moist; weak coarse subangular blocky structure parting to weak medium and fine subangular blocky; slightly hard, friable; violent effervescence (36 percent calcium carbonate); moderately alkaline; gradual wavy boundary.

C1—35 to 45 inches; light gray (2.5Y 7/2) silt loam, light olive brown (2.5Y 5/4) moist; common medium and fine distinct gray (10YR 6/1) and yellowish brown (10YR 5/6) mottles; massive; slightly hard, very friable; strong effervescence (23 percent calcium carbonate); mildly alkaline; gradual wavy boundary.

C2—45 to 60 inches; light yellowish brown (2.5Y 6/4) silt loam, light olive brown (2.5Y 5/4) moist; many coarse and medium distinct gray (10YR 6/1) and common medium and fine distinct yellowish brown (10YR 5/6) mottles; massive; slightly hard, very friable; varves 1 to 2 millimeters thick; strong effervescence (13 percent calcium carbonate); mildly alkaline.

The thickness of the mollic epipedon ranges from 7 to 15 inches. Free carbonates typically are at the surface, but some pedons are leached to a depth of 6 inches.

The A horizon has value of 3 to 5 (2 or 3 moist) and chroma of 1 or 2. It is silt loam or silty clay loam. The Bk horizon has hue of 2.5Y or 5Y, value of 6 to 8 (4 to 6 moist), and chroma of 2 to 4. It is silt loam or silty clay loam. The C horizon has hue of 2.5Y or 5Y, value of 5 to 8 (4 to 6 moist), and chroma of 2 to 4. It is silt loam or silty clay loam and is varved with very fine sand to clay in the lower part. The varves range from 1 to 5 millimeters in thickness.

Ryan Series

The Ryan series consists of deep, poorly drained soils formed in calcareous, clayey sediments on flood plains. Permeability is very slow. Slopes are less than 1 percent.

Typical pedon of Ryan silty clay loam, in an area of Ryan-Ludden complex; 1,250 feet east and 495 feet south of the northwest corner of sec. 1, T. 122 N., R. 61 W.

E—0 to 2 inches; gray (10YR 6/1) silty clay loam, very dark gray (10YR 3/1) moist; weak thin platy structure; slightly hard, friable; many fine and very fine roots; slightly acid; abrupt smooth boundary.

Bt—2 to 7 inches; dark gray (10YR 4/1) clay, black (10YR 2/1) moist; strong medium columnar structure parting to strong medium and fine angular blocky; very hard, very firm, sticky and plastic; common fine and many very fine roots; thin continuous gray (10YR 6/1) coatings on the top of columns; moderately alkaline; clear wavy boundary.

Btz—7 to 12 inches; dark gray (10YR 4/1) clay, black (10YR 2/1) moist; strong medium prismatic structure parting to strong medium and fine angular blocky; very hard, very firm, sticky and plastic; common very fine roots; many medium and fine nests of salt; slight effervescence; moderately alkaline; clear wavy boundary.

Bkz1—12 to 27 inches; gray (10YR 5/1) clay, very dark gray (10YR 3/1) moist; weak coarse and medium prismatic structure parting to moderate medium and fine angular blocky; very hard, firm, sticky and plastic; common very fine roots to a depth of 15 inches; few coarse and common medium and fine accumulations of carbonate; many medium and fine nests of salt; strong effervescence; strongly alkaline; gradual wavy boundary.

Bkz2—27 to 45 inches; gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; moderate coarse and medium subangular blocky structure; very hard, firm, sticky and plastic; common coarse and medium accumulations of carbonate; common medium and fine nests of salt; strong effervescence; strongly alkaline; gradual wavy boundary.

Bkz3—45 to 54 inches; gray (5Y 5/1) clay, dark olive gray (5Y 3/2) moist; weak coarse and medium subangular blocky structure; very hard, firm, sticky and plastic; common coarse and medium accumulations of carbonate; strong effervescence; strongly alkaline; gradual wavy boundary.

C—54 to 60 inches; gray (5Y 6/1) silty clay loam, dark gray (5Y 4/1) moist; massive; hard, firm, sticky and plastic; common fine dark stains (manganese oxide); few coarse and many medium and fine accumulations of carbonate; few medium and fine nests of salt; strong effervescence; strongly alkaline.

The thickness of the mollic epipedon ranges from 20 to more than 48 inches. The depth to free carbonates ranges from 0 to 10 inches. Some pedons have an A horizon 1 to 4 inches thick.

The E horizon has hue of 10YR, 2.5Y, or 5Y and value of 3 to 6 (2 or 3 moist). It is silty clay, clay, or silty clay loam. It is 1 or 2 inches thick. The Bt horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 or 4 (2 or 3 moist), and chroma of 1 or 2. It is clay or silty clay. The Bkz horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6 (2 to 4 moist), and chroma of 1 to 3. It is clay or silty clay. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6 (2 to 4 moist), and chroma of 1 to 3. It is clay, silty clay, or silty clay loam.

Serden Series

The Serden series consists of deep, excessively drained soils formed in wind-worked sandy glaciolacustrine material on glacial lake plains. Permeability is rapid. Slopes range from 0 to 15 percent.

Typical pedon of Serden loamy fine sand, in an area of Serden-Hamar-Venlo loamy fine sands, 0 to 6 percent slopes; 1,440 feet west and 360 feet north of the southeast corner of sec. 24, T. 128 N., R. 60 W.

A—0 to 6 inches; dark gray (10YR 4/1) loamy fine sand, very dark gray (10YR 3/1) moist; weak fine granular structure; soft, very friable; many fine roots; slightly acid; clear wavy boundary.

AC—6 to 10 inches; dark grayish brown (10YR 4/2) fine sand, very dark grayish brown (10YR 3/2) moist; single grain; loose; common fine roots; neutral; gradual wavy boundary.

C—10 to 60 inches; grayish brown (10YR 5/2) fine sand, dark grayish brown (10YR 4/2) moist; single grain; loose; neutral.

The depth to free carbonates ranges from 36 to more than 60 inches. The A horizon has value of 3 to 6 (2 to 4 moist) and chroma of 1 or 2. It is sand, loamy sand, loamy fine sand, or fine sand. Some pedons do not have an AC horizon. The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (3 to 6 moist), and chroma of 2 to 4.

Spottswood Series

The Spottswood series consists of deep, moderately well drained and somewhat poorly drained soils formed in loamy sediments that are moderately deep over gravelly sand. These soils are on outwash plains. Permeability is moderate in the subsoil and rapid in the underlying gravelly sand. Slopes range from 0 to 2 percent.

Typical pedon of Spottswood loam, in an area of Spottswood-Divide loams, 0 to 2 percent slopes; 1,910 feet west and 185 feet north of the southeast corner of sec. 30, T. 124 N., R. 63 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak fine granular; slightly hard, friable; many fine roots; neutral; abrupt smooth boundary.

Bw1—7 to 11 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium and fine subangular blocky structure; slightly hard, friable; many fine roots; neutral; clear wavy boundary.

Bw2—11 to 22 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure parting to weak coarse and medium subangular blocky; slightly hard, friable; few fine roots; mildly alkaline; clear wavy boundary.

Bk—22 to 27 inches; light gray (2.5Y 7/2) loam, grayish brown (2.5Y 5/2) moist; few fine distinct yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; slightly hard, friable; many medium and fine accumulations of carbonate; violent effervescence; mildly alkaline; abrupt wavy boundary.

2C—27 to 60 inches; pale brown (10YR 6/3) gravelly sand, dark brown (10YR 4/3) moist; single grain; loose; strong effervescence; mildly alkaline.

The thickness of the mollic epipedon and the depth to free carbonates range from 16 to 34 inches. The depth to gravelly sand ranges from 20 to 40 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is loam, silt loam, or fine sandy loam. The Bw horizon has hue of 10YR or 2.5Y and value of 3 or 4 (2 or 3 moist). It is loam or clay loam. The Bk horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 or 5 moist), and chroma of 2 or 3. It is loam or clay loam. The 2C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is loamy sand or gravelly sand.

Stirum Series

The Stirum series consists of deep, poorly drained soils formed in sandy and loamy glaciolacustrine sediments on glacial lake plains. Permeability is moderately slow in the subsoil and moderate to rapid in the underlying material. Slopes range from 0 to 3 percent.

Typical pedon of Stirum fine sandy loam, in an area of Wyndmere-Stirum fine sandy loams; 2,100 feet east and 850 feet north of the southwest corner of sec. 4, T. 128 N., R. 60 W.

A—0 to 6 inches; very dark gray (10YR 3/1) fine sandy loam, black (10YR 2/1) moist; weak medium and fine subangular blocky structure parting to weak fine granular; slightly hard, very friable; common fine and very fine roots; slight effervescence; moderately alkaline; clear wavy boundary.

Bt1—6 to 11 inches; dark gray (10YR 4/1) loam, very dark gray (10YR 3/1) moist; moderate medium columnar structure parting to moderate medium and fine subangular blocky; hard, friable; common fine and very fine roots; thin continuous gray (10YR 6/1) coatings on the top of columns; few fine crystals of salt; strong effervescence; strongly alkaline; clear wavy boundary.

Bt2—11 to 17 inches; light brownish gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; moderate coarse and medium prismatic structure parting to moderate medium and fine blocky; hard, friable; few fine roots; few fine crystals of salt; strong effervescence; strongly alkaline; clear wavy boundary.

Bk—17 to 32 inches; light gray (2.5Y 7/2) loam, light brownish gray (2.5Y 6/2) moist; weak medium and fine subangular blocky structure; slightly hard, very friable; few fine crystals of salt; violent effervescence; strongly alkaline; clear wavy boundary.

Cg1—32 to 43 inches; light gray (2.5Y 7/2) loamy very fine sand, grayish brown (2.5Y 5/2) moist; common medium and fine distinct yellowish brown (10YR 5/6) mottles; massive; soft, very friable; common fine dark stains (manganese oxide); common fine distinct strong brown (7.5YR 5/6) iron stains; strong effervescence; moderately alkaline; clear wavy boundary.

Cg2—43 to 60 inches; light gray (5Y 7/2) loamy fine sand, olive gray (5Y 5/2) moist; common medium and fine distinct yellowish brown (10YR 5/6) mottles; massive; soft, very friable; strong effervescence; moderately alkaline.

The thickness of the A horizon ranges from 3 to 13 inches. Free carbonates are at or near the surface in most pedons.

The A horizon has hue of 10YR or 2.5Y, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is fine sandy loam, very fine sandy loam, loam, loamy fine sand, or loamy very fine sand. Some pedons have an E horizon. The Bt horizon has hue of 10YR, 2.5Y, or 5Y and value of 4 to 7 (3 to 5 moist). It is sandy loam or loam. The C horizon ranges from very fine sandy loam to loamy sand. Some pedons have strata of silt, silty clay, or clay below a depth of 40 inches.

Stirum Variant

The Stirum Variant consists of deep, poorly drained soils formed in sandy and loamy glaciolacustrine sediments on glacial lake plains. Permeability is slow or very slow in the subsoil and moderately slow to rapid in the underlying material. Slopes range from 0 to 3 percent.

Typical pedon of Stirum Variant loam, in an area of Stirum-Stirum Variant loams; 1,872 feet east and 630 feet north of the southwest corner of sec. 4, T. 128 N., R. 60 W.

A—0 to 1 inch; gray (10YR 5/1) loam, very dark gray (10YR 3/1) moist; weak medium and fine subangular blocky structure parting to weak very fine granular; slightly hard, friable; many fine and very fine roots; strong effervescence; moderately alkaline; abrupt smooth boundary.

Btk—1 to 6 inches; dark gray (10YR 4/1) and light gray (2.5Y 7/2) loam, very dark gray (10YR 3/1) and light brownish gray (2.5Y 6/2) moist; strong medium columnar structure parting to strong medium and fine blocky; hard, firm; common very fine roots; thin continuous gray (10YR 6/1) coatings on the top of columns; violent effervescence; very strongly alkaline; clear irregular boundary.

Bkz—6 to 22 inches; light gray (2.5Y 7/2) fine sandy loam, light brownish gray (2.5Y 6/2) moist; weak coarse and medium prismatic structure parting to weak coarse and medium subangular blocky; hard, firm; few roots; few dark gray (10YR 4/1) tongues, very dark gray (10YR 3/1) moist; bleached sand grains on faces of peds; common fine nests of salt; violent effervescence; very strongly alkaline; clear wavy boundary.

Bk—22 to 47 inches; light gray (2.5Y 7/2) fine sandy loam, light brownish gray (2.5Y 6/2) moist; few fine faint yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; hard, firm; few

roots to a depth of 30 inches; common coarse and medium accumulations of carbonate; violent effervescence; strongly alkaline; gradual wavy boundary.

2C—47 to 60 inches; light gray (5Y 7/2) fine sand, light olive gray (5Y 6/2) moist; many medium and fine distinct dark yellowish brown (10YR 4/4) mottles; single grain; loose; strongly alkaline.

Free carbonates are at the surface in most pedons. The A horizon has value of 4 or 5 (2 or 3 moist). It is fine sandy loam or loam. It is 1 to 3 inches thick. Some pedons have an E horizon. The Btk horizon has hue of 10YR, 2.5Y, or 5Y and value of 4 to 7 (2 to 6 moist). It is loam or fine sandy loam. The Bk horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 1 or 2. It is loam or fine sandy loam. It has few to many fine nests of salt. The 2C horizon is stratified fine sand, loamy fine sand, loamy sand, very fine loamy sand, or very fine sand. Some pedons have strata of silt, silty clay, silty clay loam, or clay below a depth of 40 inches.

Svea Series

The Svea series consists of deep, moderately well drained soils formed in loamy glacial till on till plains. Permeability is moderate in the subsoil and moderately slow in the underlying material. Slopes range from 0 to 2 percent.

Typical pedon of Svea loam, in an area of Barnes-Svea-Tonka complex, 0 to 6 percent slopes; 825 feet west and 130 feet south of the northeast corner of sec. 21, T. 126 N., R. 63 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, friable; many fine and very fine roots; neutral; abrupt smooth boundary.

A—8 to 15 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak coarse and medium subangular blocky structure parting to weak medium and fine subangular blocky; slightly hard, friable; many fine and very fine roots; neutral; clear wavy boundary.

Bw1—15 to 21 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak coarse and medium prismatic structure parting to weak coarse and medium subangular blocky; hard, friable; common very fine roots; common dark gray (10YR 4/1) tongues, black (10YR 2/1) moist; neutral; clear wavy boundary.

Bw2—21 to 26 inches; grayish brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) moist; weak coarse and medium prismatic structure parting to weak coarse and medium subangular blocky; hard, friable; common very fine roots; common dark gray (10YR 4/1) tongues, black (10YR 2/1) moist; mildly alkaline; clear wavy boundary.

Bk—26 to 36 inches; pale yellow (2.5Y 7/4) clay loam, light olive brown (2.5Y 5/4) moist; weak coarse and medium subangular blocky structure; hard, friable; few fine strong brown (7.5YR 5/6) iron stains; many medium and fine accumulations of carbonate; strong effervescence; mildly alkaline; clear wavy boundary.

C1—36 to 44 inches; light yellowish brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) moist; massive; hard, friable; few fine strong brown (7.5YR 5/6) iron stains; many medium and fine accumulations of carbonate; strong effervescence; mildly alkaline; gradual wavy boundary.

C2—44 to 60 inches; light yellowish brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) moist; massive; hard, friable; few fine strong brown (7.5YR 5/6) iron stains; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 16 to 30 inches in thickness and includes part or all of the Bw horizon. The A horizon has value of 3 to 5 (2 or 3 moist). It is loam, silt loam, or clay loam. The Bw horizon has value of 3 to 5 (2 to 4 moist) and chroma of 1 to 4. It is dominantly loam but is silt loam in some pedons. The C horizon has value of 5 or 6 (4 or 5 moist) and chroma of 2 to 4. It is loam or clay loam.

Swenoda Series

The Swenoda series consists of deep, moderately well drained soils formed in loamy sediments over silty glaciolacustrine sediments. These soils are on glacial lake plains. Permeability is moderately rapid in the loamy sediments and moderate or moderately slow in the underlying material. Slopes range from 0 to 6 percent.

Typical pedon of Swenoda fine sandy loam, 0 to 2 percent slopes, 2,268 feet west and 294 feet north of the southeast corner of sec. 32, T. 126 N., R. 60 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak fine granular structure; soft, very friable; many fine and very fine roots; slightly acid; abrupt smooth boundary.

A—8 to 16 inches; dark gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak coarse subangular blocky structure parting to weak fine granular; soft, very friable; common very fine roots;

slightly acid; clear wavy boundary.

Bw1—16 to 23 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark gray (10YR 3/1) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; soft, very friable; common very fine roots; neutral; clear wavy boundary.

Bw2—23 to 31 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; soft, very friable; common very fine roots; neutral; clear wavy boundary.

Bk—31 to 37 inches; white (2.5Y 8/2) fine sandy loam, light brownish gray (2.5Y 6/2) moist; weak medium subangular blocky structure; soft, very friable; few very fine roots; violent effervescence; mildly alkaline; clear wavy boundary.

2C1—37 to 49 inches; light gray (2.5Y 7/2) silt loam, grayish brown (2.5Y 5/2) moist; common fine distinct yellowish brown (10YR 5/6) and gray (10YR 6/1) mottles; massive; soft, very friable; few very fine roots; few fine strong brown (7.5YR 5/6) iron stains; strong effervescence; mildly alkaline; gradual wavy boundary.

2C2—49 to 60 inches; pale yellow (2.5Y 7/4) silt loam, light olive (2.5Y 5/4) moist; many fine distinct yellowish brown (10YR 5/6) and gray (10YR 6/1) mottles; massive; soft, very friable; few very fine roots; common fine strong brown (7.5YR 5/6) iron stains; slight effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. The depth to free carbonates and to silty sediments ranges from 20 to 40 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is fine sandy loam, sandy loam, or loamy fine sand. The Bw horizon has hue of 10YR or 2.5Y, value of 3 to 6 (2 to 4 moist), and chroma of 1 to 3. It is fine sandy loam or sandy loam. The 2C horizon has value of 6 to 8 (4 to 6 moist) and chroma of 2 to 4. It is silt loam or silty clay loam.

Tally Series

The Tally series consists of deep, well drained soils formed in material derived from alluvium, eolian deposits, or glacial outwash. These soils are on outwash plains. Permeability is moderately rapid in the sandy sediments and moderately slow in the underlying material. Slopes range from 1 to 6 percent.

Typical pedon of Tally fine sandy loam, in an area of Tally-Letcher fine sandy loams, 1 to 6 percent slopes; 1,675 feet south and 175 feet east of the northwest corner of sec. 5, T. 128 N., R. 64 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) moist; weak fine and very fine granular structure; slightly hard, very friable; neutral; abrupt smooth boundary.

Bw1—8 to 13 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure; slightly hard, very friable; neutral; clear smooth boundary.

Bw2—13 to 22 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, very friable; neutral; gradual wavy boundary.

Bk1—22 to 34 inches; grayish brown (2.5Y 5/2) fine sandy loam, dark grayish brown (2.5Y 4/2) moist; weak medium subangular blocky structure; slightly hard, very friable; many fine accumulations of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

Bk2—34 to 43 inches; light brownish gray (2.5Y 6/2) fine sandy loam, grayish brown (2.5Y 5/2) moist; weak medium subangular blocky structure; slightly hard, very friable; common fine accumulations of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

C1—43 to 52 inches; light yellowish brown (2.5Y 6/4) fine sandy loam, light olive brown (2.5Y 5/4) moist; common fine distinct yellowish brown (10YR 5/8) and few fine distinct gray (10YR 6/1) mottles; massive; slightly hard, very friable; strong effervescence; moderately alkaline; clear smooth boundary.

2C2—52 to 60 inches; light yellowish brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) moist; common fine distinct yellowish brown (10YR 5/8) and gray (10YR 6/1) mottles; massive; hard, friable; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 10 to 15 inches. The depth to free carbonates ranges from 15 to 30 inches.

The A horizon has value of 3 to 5 (2 or 3 moist). It is fine sandy loam or sandy loam. The Bw horizon has hue of 2.5Y or 10YR, value of 4 or 5 (2 to 4 moist), and chroma of 2 or 3. It is fine sandy loam or sandy loam. The Bk horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is fine sandy loam, sandy loam, or loamy fine sand. The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is loamy fine sand, loamy sand, fine sand, fine sandy loam, or sandy loam. The 2C

horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is loam or clay loam. Some pedons do not have a 2C horizon.

Tiffany Series

The Tiffany series consists of deep, somewhat poorly drained and poorly drained soils formed in glaciolacustrine sediments on glacial lake plains. Permeability is moderate. Slopes are less than 1 percent.

Typical pedon of Tiffany fine sandy loam, in an area of Embden-Tiffany fine sandy loams; 900 feet north and 650 feet west of the southeast corner of sec. 29, T. 126 N., R. 60 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak fine granular; soft, very friable; many fine and very fine roots; slightly acid; abrupt smooth boundary.

A1—7 to 12 inches; dark gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak medium subangular blocky structure; soft, very friable; common very fine roots; slightly acid; clear wavy boundary.

A2—12 to 23 inches; dark gray (10YR 4/1) fine sandy loam, very dark gray (10YR 3/1) moist; common fine distinct dark reddish brown (5YR 3/3) and dark brown (10YR 4/3) mottles; weak coarse and medium subangular blocky structure; soft, very friable; common very fine roots; slightly acid; gradual wavy boundary.

C1—23 to 30 inches; light brownish gray (2.5Y 6/2) loamy very fine sand, dark grayish brown (2.5Y 4/2) moist; many fine distinct dark brown (7.5YR 4/4) and yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; soft, very friable; common very fine roots; neutral; gradual wavy boundary.

C2—30 to 49 inches; light brownish gray (2.5Y 6/2) loamy very fine sand, grayish brown (2.5Y 5/2) moist; many fine distinct dark brown (7.5YR 4/4) and yellowish brown (10YR 5/6) mottles; massive; soft, very friable; few very fine roots; neutral; gradual wavy boundary.

Cg—49 to 60 inches; light olive gray (5Y 6/2) loamy very fine sand, olive gray (5Y 5/2) moist; many fine distinct yellowish brown (10YR 5/6) and common fine distinct dark brown (7.5YR 4/4) mottles; massive; soft, very friable; slight effervescence; neutral.

The thickness of the mollic epipedon ranges from 10 to 24 inches. The depth to free carbonates ranges from 20 to 50 inches.

The A horizon has value of 3 to 5. It is fine sandy loam, sandy loam, loam, or very fine sandy loam. The C horizon has a wide range of colors because of the mottles. It is commonly stratified. It is fine sandy loam, loamy fine sand, or loamy very fine sand.

Tiffany Variant

The Tiffany Variant consists of deep, somewhat poorly drained and poorly drained soils formed in sandy sediments over silty sediments. These soils are on glacial lake plains. Permeability is moderate in the sandy sediments and moderate to slow in the underlying material. Slopes range from 0 to 2 percent.

Typical pedon of Tiffany Variant fine sandy loam, in an area of Swenoda-Tiffany Variant fine sandy loams, 0 to 3 percent slopes; 2,460 feet west and 990 feet south of the northeast corner of sec. 24, T. 126 N., R. 60 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak fine granular structure; soft, very friable; common fine and very fine roots; neutral; abrupt smooth boundary.

A—8 to 13 inches; dark gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; few fine faint dark yellowish brown (10YR 4/4 and 4/6) mottles; weak medium subangular blocky structure parting to weak fine granular; soft, very friable; common fine and very fine roots; neutral; clear smooth boundary.

Bw—13 to 21 inches; grayish brown (2.5Y 5/2) loamy very fine sand, very dark grayish brown (2.5Y 3/2) moist; many fine faint dark yellowish brown (10YR 4/6) mottles; weak coarse and medium subangular blocky structure parting to weak medium and fine subangular blocky; soft, very friable; few fine and very fine roots; neutral; gradual wavy boundary.

Bk1—21 to 35 inches; light brownish gray (2.5Y 6/2) loamy very fine sand, dark grayish brown (2.5Y 4/2) moist; many fine faint dark yellowish brown (10YR 4/6) mottles; weak coarse and medium subangular blocky structure parting to weak medium and fine subangular blocky; soft, very friable; few fine and very fine roots; strong effervescence; moderately alkaline; gradual wavy boundary.

2Bk2—35 to 43 inches; light gray (2.5Y 7/2) silt loam, light yellowish brown (2.5Y 6/4) moist; common medium and fine faint brownish yellow (10YR 6/6) mottles; weak coarse and medium subangular blocky structure parting to weak medium and fine subangular blocky; hard, friable; violent effervescence; moderately alkaline; gradual wavy boundary.

2C1—43 to 52 inches; light gray (2.5Y 7/2) silt loam, light yellowish brown (2.5Y 6/4) moist; common medium and fine distinct gray (10YR 6/1) and yellowish brown (10YR 5/6) mottles; massive; hard, friable; strong effervescence; moderately alkaline; gradual wavy boundary.

2C2—52 to 60 inches; light gray (2.5Y 7/2) silt loam, light yellowish brown (2.5Y 6/4) moist; many coarse and medium distinct gray (10YR 6/1) and yellowish brown (10YR 5/6) mottles; massive; slightly hard, friable; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 10 to 24 inches. The depth to free carbonates and to silty sediments ranges from 20 to 40 inches.

The A horizon has value of 3 to 5 (2 or 3 moist). It is fine sandy loam, sandy loam, or very fine sandy loam. It is 7 to 16 inches thick. The Bw horizon has hue of 10YR or 2.5Y, value of 3 to 6 (2 to 4 moist), and chroma of 1 to 3. It is loamy very fine sand, loamy fine sand, or fine sandy loam. The Bk horizon has hue of 2.5Y or 5Y, value of 5 to 7 (3 to 5 moist), and chroma of 1 to 4. It is loamy very fine sand, loamy fine sand, or fine sandy loam. The 2Bk horizon has hue of 2.5Y or 5Y, value of 6 to 8 (4 to 6 moist), and chroma of 2 to 4. It is silt loam, silty clay loam, or loam. The 2C horizon is silt loam, silty clay loam, or loam.

Tonka Series

The Tonka series consists of deep, poorly drained soils formed in clayey alluvium on till plains and glacial lake plains. Permeability is slow. Slopes are less than 1 percent.

Typical pedon of Tonka silt loam, in an area of Winship-Tonka silt loams; 2,580 feet west and 775 feet north of the southeast corner of sec. 22, T. 123 N., R. 63 W.

Ap—0 to 9 inches; gray (10YR 5/1) silt loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, friable; common fine roots; medium acid; abrupt smooth boundary.

E—9 to 18 inches; light gray (10YR 7/1) silt loam, dark grayish brown (10YR 4/2) moist; common fine distinct yellowish brown (10YR 5/6) mottles; moderate thin platy structure; slightly hard, friable; few fine roots; slightly acid; abrupt wavy boundary.

Bt1—18 to 34 inches; gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; moderate coarse prismatic structure parting to strong medium and fine blocky; very hard, firm, sticky and plastic; few fine and very fine roots; continuous shiny films on vertical faces of peds; bleached sand grains on the top of prisms and extending about 4 inches along the vertical faces of peds; slightly acid; clear wavy boundary.

Bt2—34 to 39 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; many medium and fine distinct yellowish brown (10YR 5/6) mottles; weak coarse prismatic structure parting to strong fine blocky; hard, firm, sticky and plastic; few very fine roots; discontinuous shiny films on vertical faces of peds; slightly acid; clear wavy boundary.

BC—39 to 50 inches; light gray (2.5Y 7/2) silty clay loam, grayish brown (2.5Y 5/2) moist; common medium distinct olive yellow (2.5Y 6/6) and few fine distinct gray (10YR 6/1) mottles; weak coarse prismatic structure parting to weak medium subangular blocky; hard, firm, sticky and plastic; few fine concretions of manganese oxide; slightly acid; gradual wavy boundary.

Cg—50 to 60 inches; light gray (2.5Y 7/2) silty clay loam, grayish brown (2.5Y 5/2) moist; many coarse and medium distinct light olive brown (2.5Y 5/6), common coarse and medium distinct yellowish brown (10YR 5/6), and few fine distinct gray (10YR 6/1) mottles; massive; hard, friable, sticky and plastic; few fine concretions of manganese oxide; neutral.

The depth to free carbonates ranges from 28 to more than 60 inches. The A horizon has hue of 10YR or is neutral in hue. It has value of 3 to 5 (2 or 3 moist). It is silt loam, loam, or silty clay loam. The E horizon has hue of 10YR or 2.5Y and value of 5 to 7 (3 to 5 moist). It is loam, silt loam, very fine sandy loam, or silty clay loam. The Bt horizon has hue of 10YR, 2.5Y, or 5Y and value of 4 to 6 (2 to 4 moist). It is silty clay, clay loam, clay, or silty clay loam. The C horizon has hue of 2.5Y or 5Y, value of 6 or 7 (5 or 6 moist), and chroma of 1 or 2. It is silty clay, clay loam, or silty clay loam.

Towner Series

The Towner series consists of deep, well drained and moderately well drained soils formed in sandy sediments over silty glaciolacustrine sediments. These soils are on glacial lake plains. Permeability is rapid in the sandy sediments and moderate or moderately slow in the underlying material. Slopes range from 0 to 3 percent.

Typical pedon of Towner loamy fine sand, in an area of Towner-Hecla loamy fine sands; 510 feet east and 168 feet south of the northwest corner of sec. 8, T. 128 N., R. 60 W.

Ap—0 to 6 inches; dark gray (10YR 4/1) loamy fine sand, black (10YR 2/1) moist; weak medium and fine subangular blocky structure parting to weak fine granular; soft, very friable; many fine and very fine roots; neutral; abrupt smooth boundary.

A—6 to 20 inches; dark gray (10YR 4/1) loamy fine sand, black (10YR 2/1) moist; weak very coarse prismatic structure parting to weak medium and fine subangular blocky; soft, very friable; common fine and very fine roots; neutral; clear wavy boundary.

Bw—20 to 28 inches; grayish brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak very coarse prismatic structure parting to weak coarse and medium subangular blocky; soft, very friable; few fine roots; neutral; abrupt wavy boundary.

2Bk—28 to 42 inches; light gray (2.5Y 7/2) silt loam, light brownish gray (2.5Y 6/2) moist; common fine faint yellowish brown (10YR 5/6) mottles; weak coarse and medium subangular blocky structure; hard, friable; few fine roots; few fine dark stains (manganese oxide); few fine nests and threads of gypsum and other salts; violent effervescence; mildly alkaline; gradual wavy boundary.

2C—42 to 60 inches; pale olive (5Y 6/3) silt loam, olive (5Y 5/3) moist; common fine distinct gray (10YR 6/1) and few fine distinct yellowish brown (10YR 5/6) mottles; massive; hard, friable; few fine threads and nests of gypsum and other salts; strong effervescence; mildly alkaline.

The mollic epipedon ranges from 16 to 30 inches in thickness. The depth to silty sediments ranges from 20 to 40 inches.

The A horizon typically has value of 3 or 4 (2 or 3 moist). Below a depth of about 10 inches, however, it has hue of 10YR or 2.5Y, value of 3 to 6 (2 to 4 moist), and chroma of 1 or 2. It is loamy sand, loamy fine sand, sandy loam, or fine sandy loam. The Bw horizon has hue of 10YR or 2.5Y, value of 4 to 6 (3 to 5 moist), and chroma of 2 or 3. It is loamy sand, loamy fine sand, or fine sand. The 2C horizon has hue of 2.5Y or 5Y, value of 6 to 8 (4 to 6 moist), and chroma of 2 to 4. It is silt loam, loam, or silty clay loam.

Turton Series

The Turton series consists of deep, moderately well drained and somewhat poorly drained soils formed in loamy glaciolacustrine sediments on glacial lake plains. Permeability is slow in the subsoil and moderate to slow in the underlying material. Slopes range from 0 to 2 percent.

Typical pedon of Turton loam, in an area of Turton-Turton Variant complex; 2,220 feet north and 525 feet east of the southwest corner of sec. 20, T. 126 N., R. 61 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium and fine subangular blocky structure parting to weak very fine granular; slightly hard, friable; many fine and very fine roots; medium acid; abrupt smooth boundary.

A—7 to 15 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak very fine granular; slightly hard, friable; many fine and very fine roots; many fine pores; medium acid; clear smooth boundary.

E—15 to 19 inches; light brownish gray (10YR 6/2) very fine sandy loam, dark grayish brown (10YR 4/2) moist; common fine faint yellowish brown (10YR 5/6) mottles; weak thin platy structure; slightly hard, very friable; common very fine roots; many fine pores; neutral; abrupt wavy boundary.

Bt1—19 to 23 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; strong coarse and medium columnar structure parting to moderate coarse and medium angular blocky; very hard, friable; common very fine roots along faces of peds; few fine pores; thin continuous gray (10YR 6/1) coatings on the top of columns; coatings of clean sand grains on faces of peds; strongly alkaline; clear wavy boundary.

Bt2—23 to 27 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate coarse and medium prismatic structure parting to moderate coarse and medium angular blocky; very hard, friable; few very fine roots along faces of peds; coatings of clean sand grains on faces of peds; strongly alkaline; clear wavy boundary.

Btkz—27 to 41 inches; grayish brown (2.5Y 5/2) loam, very dark grayish brown (2.5Y 3/2) moist; moderate coarse and medium prismatic structure parting to moderate coarse and medium angular blocky; very hard, friable; common medium and fine accumulations of carbonate; common fine nests of salt; strong effervescence; strongly alkaline; clear wavy boundary.

Bkz—41 to 47 inches; light brownish gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; weak coarse and medium prismatic structure parting to weak medium angular blocky; hard, friable; many coarse medium and fine accumulations of carbonate; common fine nests of salt; violent effervescence; very strongly alkaline; gradual wavy boundary.

C—47 to 60 inches; light gray (2.5Y 7/2) very fine

sandy loam, light brownish gray (2.5Y 6/2) moist; many fine distinct yellowish brown (10YR 5/6) and common medium and fine faint gray (10YR 6/1) mottles; massive; slightly hard, friable; common fine nests of salt; strong effervescence; strongly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The surface soil is 9 to 22 inches thick. The depth to carbonates ranges from 18 to 35 inches. The depth to accumulations of salt ranges from 16 to 30 inches.

The A horizon has value of 3 to 5 (2 or 3 moist). It is loam, fine sandy loam, or very fine sandy loam. The E horizon has value of 5 to 7 (3 to 5 moist) and chroma of 1 or 2. It is fine sandy loam, very fine sandy loam, or loam. The Bt horizon has value of 4 to 6 (2 to 4 moist) and chroma of 1 to 3. It is loam, silt loam, silty clay loam, or clay loam. The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is silt loam, loam, fine sandy loam, or very fine sandy loam.

Turton Variant

The Turton Variant consists of deep, somewhat poorly drained soils formed in loamy glaciolacustrine sediments on glacial lake plains. Permeability is very slow in the subsoil and moderate to slow in the underlying material. Slopes range from 0 to 2 percent.

Typical pedon of Turton Variant very fine sandy loam, in an area of Turton-Turton Variant complex; 2,442 feet north and 1,131 feet west of the southeast corner of sec. 19, T. 126 N., R. 61 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) very fine sandy loam, black (10YR 2/1) moist; weak medium and fine subangular blocky structure parting to weak very fine granular; slightly hard, very friable; common fine and very fine roots; slightly acid; abrupt smooth boundary.

Bt1—8 to 15 inches; dark grayish brown (10YR 4/2) very fine sandy loam, very dark grayish brown (10YR 3/2) moist; moderate coarse columnar structure parting to weak coarse and medium subangular blocky; very hard, friable; common fine and very fine roots along faces of peds; thin continuous gray (10YR 6/1) coatings on the top of columns; few fine nests of salt; slight effervescence; strongly alkaline; clear wavy boundary.

Bt2—15 to 24 inches; grayish brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) moist; moderate coarse prismatic structure parting to moderate medium and fine subangular blocky; very hard, friable; clean sand grains on faces of peds; few fine nests of salt; slight effervescence; very strongly alkaline; clear wavy boundary.

Bk1—24 to 34 inches; white (2.5Y 8/0) loam, light gray (2.5Y 7/2) moist; weak coarse prismatic structure parting to weak medium and fine subangular blocky; hard, friable; common grayish brown (2.5Y 5/2) tongues, dark grayish brown (2.5Y 4/2) moist; few fine nests of salt; violent effervescence; very strongly alkaline; clear wavy boundary.

Bk2—34 to 45 inches; white (2.5Y 8/2) loam, light brownish gray (2.5Y 6/2) moist; common fine faint gray (10YR 6/1) and common fine distinct yellowish brown (10YR 5/6) mottles; weak coarse and medium subangular blocky structure; hard, friable; common grayish brown (2.5Y 5/2) tongues, dark grayish brown (2.5Y 4/2) moist; few fine concretions of manganese oxide; few fine nests of salt; violent effervescence; very strongly alkaline; gradual wavy boundary.

C—45 to 60 inches; white (2.5Y 8/2) very fine sandy loam, light brownish gray (2.5Y 6/2) moist; many medium and fine faint gray (10YR 6/1), many medium and fine distinct yellowish brown (10YR 5/6), and few fine prominent dark brown (7.5YR 3/4) mottles; massive; slightly hard, friable; few fine concretions of manganese oxide; varves 1 to 2 millimeters thick; strong effervescence; strongly alkaline.

The depth to free carbonates ranges from 4 to 12 inches. The depth to accumulations of salt ranges from 6 to 16 inches.

The A horizon has value of 3 to 5 (2 or 3 moist). It is very fine sandy loam, loam, fine sandy loam, or silt loam. It is 4 to 10 inches thick. Some pedons have an E horizon. The Bt horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6 (2 to 4 moist), and chroma of 1 to 3. It is very fine sandy loam, loam, silt loam, or silty clay loam. The Bk horizon has hue of 2.5Y or 5Y or is neutral in hue. It has value of 5 to 8 (4 to 7 moist) and chroma of 0 to 4. It is loam, very fine sandy loam, silt loam, or clay loam. The C horizon has hue of 2.5Y or 5Y, value of 5 to 8 (4 to 7 moist), and chroma of 2 to 4. It is very fine sandy loam, silt loam, loam, or clay loam.

Ulen Series

The Ulen series consists of deep, moderately well drained and somewhat poorly drained soils formed in sandy glaciolacustrine sediments on glacial lake plains. Permeability is rapid. Slopes range from 0 to 3 percent.

Typical pedon of Ulen fine sandy loam, 1,960 feet

east and 132 feet south of the northwest corner of sec. 5, T. 126 N., R. 61 W.

Ap—0 to 9 inches; dark gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak fine granular structure; soft, very friable; common fine and very fine roots; strong effervescence (9 percent calcium carbonate); mildly alkaline; abrupt smooth boundary.

Ak—9 to 14 inches; gray (10YR 5/1) fine sandy loam, very dark gray (10YR 3/1) moist; weak medium subangular blocky structure; soft, very friable; common fine and very fine roots; violent effervescence (13 percent calcium carbonate); moderately alkaline; clear wavy boundary.

Bk—14 to 22 inches; light gray (10YR 7/1) loamy fine sand, grayish brown (2.5Y 5/2) moist; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; soft, very friable; few very fine roots; violent effervescence (14 percent calcium carbonate); moderately alkaline; gradual wavy boundary.

C1—22 to 38 inches; light gray (2.5Y 7/2) loamy fine sand, light olive brown (2.5Y 5/4) moist; many medium and fine distinct yellowish brown (10YR 5/6) and gray (10YR 6/1) mottles; weak medium subangular blocky structure; soft, very friable; strong effervescence (11 percent calcium carbonate); moderately alkaline; gradual wavy boundary.

C2—38 to 54 inches; light gray (2.5Y 7/2) fine sand, olive brown (2.5Y 4/4) moist; many medium and fine distinct yellowish brown (10YR 5/6) and gray (10YR 6/1) mottles; weak medium subangular blocky structure; soft, very friable; slight effervescence (5 percent calcium carbonate); mildly alkaline; gradual wavy boundary.

C3—54 to 60 inches; light gray (2.5Y 7/2) fine sand, olive brown (2.5Y 4/4) moist; many medium and fine distinct yellowish brown (10YR 5/6) and gray (10YR 6/1) mottles; single grain; loose; slight effervescence; mildly alkaline.

The mollic epipedon ranges from 10 to 20 inches in thickness. Free carbonates are throughout the solum.

The A horizon has value of 3 or 4 (2 or 3 moist) and chroma of 1 or 2. It is fine sandy loam, loamy fine sand, or very fine sandy loam. The Bk horizon has value of 5 to 7 (4 or 5 moist) and chroma of 1 to 3. It is loamy sand, loamy fine sand, sandy loam, or fine sandy loam. The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 6. It is loamy fine sand, fine sand, or very fine sand. In some pedons it is loam, silt loam, or silty clay loam below a depth of 40 inches.

Vallers Series

The Vallers series consists of deep, poorly drained soils formed in calcareous glacial till on till plains. Permeability is moderately slow. Slopes range from 0 to 2 percent.

Typical pedon of Vallers clay loam, 850 feet south and 50 feet east of the northwest corner of sec. 6, T. 128 N., R. 62 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) clay loam, black (10YR 2/1) moist; moderate medium and fine subangular blocky structure; hard, friable; slight effervescence; neutral; abrupt smooth boundary.

A—7 to 10 inches; very dark gray (10YR 3/1) clay loam, black (10YR 2/1) moist; moderate medium and fine subangular blocky structure; hard, friable; few fine accumulations of carbonate; slight effervescence; neutral; clear wavy boundary.

Bkg—10 to 23 inches; light gray (5Y 7/2) clay loam, olive gray (5Y 5/2) moist; few fine distinct yellowish brown (10YR 5/6) and dark yellowish brown (10YR 4/6) mottles; weak fine and very fine subangular blocky structure; slightly hard, friable; few medium and fine accumulations of carbonate; violent effervescence; moderately alkaline; clear wavy boundary.

Cg1—23 to 30 inches; light olive gray (5Y 6/2) clay loam, olive gray (5Y 5/2) moist; common fine distinct yellowish brown (10YR 5/6) mottles; massive; hard, friable; few fine dark stains (manganese oxide); few fine strong brown (7.5YR 5/6) iron stains; few fine accumulations of carbonate; violent effervescence; mildly alkaline; gradual wavy boundary.

Cg2—30 to 50 inches; light olive gray (5Y 6/2) clay loam, olive gray (5Y 4/2) moist; many medium and fine distinct yellowish brown (10YR 5/6) and dark yellowish brown (10YR 4/6) mottles; massive; hard, friable; few fine dark stains (manganese oxide); common fine strong brown (7.5YR 5/6) iron stains; few fine accumulations of carbonate; few fine nests of salt; strong effervescence; mildly alkaline; clear wavy boundary.

Cg3—50 to 60 inches; light gray (5Y 7/2) clay loam, olive gray (5Y 5/2) moist; many medium and fine distinct yellowish brown (10YR 5/8) mottles; massive; hard, friable; few fine dark stains (manganese oxide); few fine strong brown (7.5YR 5/6) iron stains; few fine accumulations of

carbonate; few medium and fine nests of salt; strong effervescence; mildly alkaline.

The mollic epipedon ranges from 7 to 25 inches in thickness. Typically, the soils are calcareous throughout.

The A horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 3 or 4 (2 or 3 moist) and chroma of 0 or 1. It is clay loam, sandy clay loam, silty clay loam, or loam. The Bkg horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 4 to 7 (3 to 6 moist) and chroma of 0 to 2. It is clay loam, silty clay loam, or sandy clay loam. The Cg horizon has hue of 2.5Y or 5Y, value of 5 to 8 (4 to 7 moist), and chroma of 1 to 3. It is clay loam or loam.

Vang Series

The Vang series consists of deep, well drained soils formed in loamy sediments that are moderately deep over shaly and sandy sediments. These soils are on outwash plains. Permeability is moderate in the subsoil and rapid or very rapid in the underlying material. Slopes range from 2 to 6 percent.

Typical pedon of Vang loam (fig. 15), in an area of Brantford Variant-Vang loams, 2 to 6 percent slopes; 2,568 feet west and 192 feet south of the northeast corner of sec. 35, T. 125 N., R. 65 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate medium subangular blocky structure parting to weak fine granular; slightly hard, very friable; common fine and many very fine roots; slightly acid; abrupt smooth boundary.

Bw1—7 to 13 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable; few very fine roots; neutral; clear wavy boundary.

Bw2—13 to 21 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to moderate coarse and medium subangular blocky; slightly hard, very friable; few very fine roots; neutral; clear wavy boundary.

Bw3—21 to 27 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, friable; few very fine roots; neutral; clear wavy boundary.

C1—27 to 35 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, friable; few very fine roots; about 20 percent shale fragments; slight effervescence; neutral; clear wavy boundary.

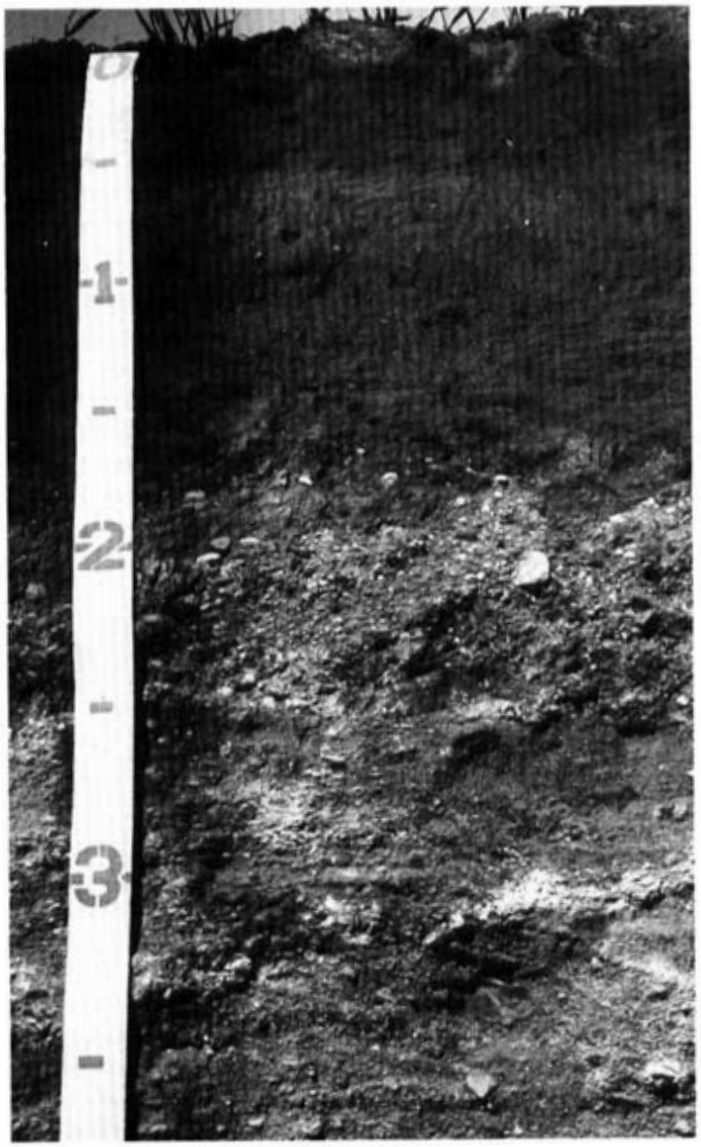

Figure 15.—Profile of a Vang loam. Gravelly sand that contains shale fragments is at a depth of about 22 inches. Depth is marked in feet.

2C2—35 to 60 inches; light brownish gray (2.5Y 6/2) gravelly sand, dark grayish brown (2.5Y 4/2) moist; single grain; loose; about 45 percent shale fragments; strong effervescence; mildly alkaline.

The mollic epipedon ranges from 16 to 30 inches in thickness. The depth to stratified sandy and shaly material ranges from 20 to 40 inches. The content of shale fragments ranges from 2 to 20 percent in the C

horizon and from 35 to 50 percent in the 2C horizon.

The A horizon has value of 3 or 4 (2 or 3 moist). It is loam or clay loam. The Bw horizon has hue of 10YR or 2.5Y, value of 4 to 6 (2 to 4 moist), and chroma of 1 to 3. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 1 to 3. It is loam or clay loam. The 2C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (3 to 6 moist), and chroma of 1 to 4.

Venlo Series

The Venlo series consists of deep, very poorly drained soils formed in sands on glacial lake plains. Permeability is rapid. Slopes are less than 1 percent.

Typical pedon of Venlo loamy fine sand, in an area of Serden-Hamar-Venlo loamy fine sands, 0 to 6 percent slopes; 1,400 feet north and 1,200 feet east of the southwest corner of sec. 23, T. 128 N., R. 60 W.

A—0 to 10 inches; very dark gray (10YR 3/1) loamy fine sand, black (10YR 2/1) moist; weak fine granular structure; soft, very friable; neutral; clear wavy boundary.

Cg1—10 to 28 inches; light olive gray (5Y 6/2) fine sand, olive gray (5Y 5/2) moist; common fine distinct yellowish brown (10YR 5/6 and 5/8) and very dark brown (10YR 2/2) mottles; single grain; loose; mildly alkaline; gradual wavy boundary.

Cg2—28 to 45 inches; light gray (5Y 7/2) fine sand, olive gray (5Y 5/2) moist; common fine distinct yellowish brown (10YR 5/6) and dark yellowish brown (10YR 4/4) mottles; single grain; loose; mildly alkaline; gradual wavy boundary.

Cg3—45 to 60 inches; gray (5Y 6/1) fine sand, dark gray (5Y 4/1) moist; common fine faint yellowish brown (10YR 5/4) mottles; single grain; loose; common fine dark stains (manganese oxide); mildly alkaline.

The thickness of the mollic epipedon ranges from 10 to 20 inches. Some pedons have a buried A horizon.

The A horizon has hue of 10YR, 2.5Y, or 5Y and value of 3 to 5 (1 to 3 moist). It is loamy fine sand or fine sandy loam. The Cg horizon has hue of 2.5Y or 5Y or is neutral in hue. It has value of 5 to 8 (4 to 6 moist). It is loamy fine sand or fine sand.

Vida Series

The Vida series consists of deep, well drained soils formed in glacial till on moraines. Permeability is moderate in the subsoil and moderately slow in the underlying material. Slopes range from 6 to 25 percent.

Typical pedon of Vida loam, in an area of Williams-Vida loams, 6 to 15 percent slopes; 1,000 feet east and 460 feet south of the northwest corner of sec. 6, T. 126 N., R. 65 W.

A—0 to 5 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, friable; many very fine roots; neutral; abrupt smooth boundary.

Bt—5 to 9 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable; common very fine roots; neutral; clear wavy boundary.

Bk—9 to 22 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; slightly hard, friable; few very fine roots; many medium and fine accumulations of carbonate; violent effervescence; mildly alkaline; clear wavy boundary.

C1—22 to 35 inches; light brownish gray (2.5Y 6/2) clay loam, olive brown (2.5Y 4/4) moist; massive; slightly hard, friable; few fine strong brown (7.5YR 5/6) iron stains; few medium and fine accumulations of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—35 to 60 inches; light yellowish brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) moist; few fine faint yellowish brown (10YR 5/6) and gray (10YR 6/1) mottles; massive; slightly hard, friable; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 7 to 10 inches in thickness. The depth to free carbonates ranges from 6 to 10 inches.

The A horizon has value of 3 or 4 (2 or 3 moist) and chroma of 2 or 3. It is loam or clay loam. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5 (3 or 4 moist), and chroma of 2 or 3. The Bk horizon has hue of 10YR or 2.5Y, value of 6 or 7 (5 or 6 moist), and chroma of 2 or 3. It is loam or clay loam. The C horizon has hue of 10YR or 2.5Y, value of 6 or 7 (4 to 6 moist), and chroma of 1 to 4. It is loam or clay loam.

Wabek Variant

The Wabek Variant consists of excessively drained soils formed in loamy sediments that are shallow or very shallow to gravelly sand, which overlies glacial till. These soils are on outwash plains and moraines. Permeability is very rapid in the sandy sediments and moderately slow in the underlying material. Slopes range from 9 to 15 percent.

Typical pedon of Wabek Variant gravelly loam, in an area of Zahl-Embden-Wabek Variant complex, 3 to 15

percent slopes; 1,670 feet north and 250 feet west of the southeast corner of sec. 14, T. 128 N., R. 65 W.

A—0 to 7 inches; dark grayish brown (10YR 4/2) gravelly loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, very friable; many fine and very fine roots; slightly acid; clear wavy boundary.

2C1—7 to 11 inches; dark brown (10YR 4/3) gravelly loamy sand, very dark grayish brown (10YR 3/2) moist; single grain; loose; common very fine roots; slight effervescence; neutral; clear wavy boundary.

2C2—11 to 27 inches; pale brown (10YR 6/3) very gravelly sand, dark brown (10YR 4/3) moist; single grain; loose; few very fine roots; strong effervescence; neutral; gradual wavy boundary.

3C3—27 to 60 inches; light yellowish brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) moist; massive; hard, firm; few fine strong brown (7.5YR 5/6) iron stains; strong effervescence; mildly alkaline.

The depth to gravelly sand ranges from 7 to 14 inches, and the depth to the underlying glacial till ranges from 20 to 40 inches. The depth to free carbonates generally ranges from 4 to 9 inches, but some pedons are leached to the glacial till.

The A horizon has value of 4 or 5 (2 or 3 moist). It typically is gravelly loam, but it is loam, sandy loam, loamy sand, gravelly sandy loam, or gravelly loamy sand in some pedons. It is 5 to 11 inches thick. The 2C horizon has value of 4 to 6 (3 to 5 moist) and chroma of 2 to 4. It is gravelly sand, very gravelly sand, gravelly loamy sand, or gravelly coarse sandy loam. The 3C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is clay loam or loam.

Williams Series

The Williams series consists of deep, well drained soils formed in glacial till on till plains and moraines. Permeability is moderate in the subsoil and moderately slow in the underlying material. Slopes range from 0 to 15 percent.

Typical pedon of Williams loam, in an area of Williams-Bowbells loams, 1 to 6 percent slopes; 2,195 feet north and 145 feet east of the southwest corner of sec. 17, T. 123 N., R. 64 W.

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

Bt1—7 to 11 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) crushing to brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable; common very fine roots; discontinuous shiny films on vertical faces of peds; neutral; clear wavy boundary.

Bt2—11 to 17 inches; grayish brown (10YR 5/2) clay loam, brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate coarse and medium subangular blocky; hard, friable; common very fine roots; discontinuous shiny films on vertical faces of peds; neutral; clear wavy boundary.

Bk1—17 to 22 inches; light brownish gray (2.5Y 6/2) clay loam, olive brown (2.5Y 4/4) moist; moderate coarse and medium subangular blocky structure; hard, friable; few very fine roots; common grayish brown (10YR 5/2) tongues, dark brown (10YR 4/3) moist; common fine accumulations of carbonate; strong effervescence; mildly alkaline; clear wavy boundary.

Bk2—22 to 40 inches; light gray (2.5Y 7/2) clay loam, light olive brown (2.5Y 5/4) moist; few fine faint yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; slightly hard, friable; many fine accumulations of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

C—40 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, light olive brown (2.5Y 5/4) moist; common fine faint yellowish brown (10YR 5/6) and few fine distinct yellowish red (5YR 5/6) mottles; massive; slightly hard, friable; strong effervescence; moderately alkaline.

The depth to free carbonates ranges from 10 to 30 inches. The A horizon has value of 4 or 5 (2 or 3 moist). It is loam, silt loam, or clay loam. In some areas that support native grasses, it has moist chroma of 1 in the upper 3 inches. The Bt horizon has hue of 10YR or 2.5Y and value of 4 to 6 (3 to 5 moist). It is loam or clay loam. The C horizon has hue of 2.5Y or 5Y, value of 5 to 8 (4 to 6 moist), and chroma of 2 to 4. It is loam or clay loam.

Winship Series

The Winship series consists of deep, somewhat poorly drained soils formed in silty alluvial deposits and glaciolacustrine sediments on glacial lake plains. Permeability is moderately slow in the subsoil and moderately slow or slow in the underlying material. Slopes range from 0 to 2 percent.

Typical pedon of Winship silt loam, in an area of

Winship-Tonka silt loams; 1,860 feet west and 1,190 feet north of the southeast corner of sec. 27, T. 124 N., R. 61 W.

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

A—7 to 22 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak coarse subangular blocky structure parting to weak fine granular; slightly hard, very friable; common fine and very fine roots; mildly alkaline; clear wavy boundary.

BA—22 to 33 inches; gray (10YR 5/1) silty clay loam, black (10YR 2/1) moist; weak fine prismatic structure parting to weak fine subangular blocky; hard, friable, slightly sticky and slightly plastic; few fine roots; light gray (10YR 6/1) coatings on faces of peds; neutral; clear smooth boundary.

Bt1—33 to 40 inches; gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; weak medium prismatic structure parting to moderate medium and fine subangular blocky; hard, friable, slightly sticky and slightly plastic; light gray (10YR 6/1) coatings on faces of peds; neutral; clear wavy boundary.

Bt2—40 to 48 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; common medium distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; neutral; clear wavy boundary.

C—48 to 60 inches; light gray (2.5Y 7/2) silt loam, grayish brown (2.5Y 5/2) moist; many medium distinct yellowish brown (10YR 5/4) mottles; massive; hard, friable; mildly alkaline.

The mollic epipedon ranges from 32 to more than 60 inches. The depth to free carbonates ranges from 40 to more than 60 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is silt loam or silty clay loam. The Bt horizon has value of 4 to 6. Some pedons have a BC or Bk horizon. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 6 or 7 (5 or 6 moist), and chroma of 2 or 3. It is silt loam or silty clay loam.

Wyndmere Series

The Wyndmere series consists of deep, somewhat poorly drained soils formed in glaciolacustrine sediments on glacial lake plains. Permeability is moderately rapid. Slopes are less than 3 percent.

Typical pedon of Wyndmere fine sandy loam, 2,050 feet east and 50 feet south of the northwest corner of sec. 32, T. 126 N., R. 60 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak fine granular; slightly hard, very friable; common fine and very fine roots; strong effervescence; mildly alkaline; abrupt smooth boundary.

Bk1—8 to 15 inches; gray (10YR 5/1) fine sandy loam, very dark gray (10YR 3/1) moist; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, very friable; few very fine roots; violent effervescence; mildly alkaline; gradual wavy boundary.

Bk2—15 to 26 inches; gray (10YR 6/1) fine sandy loam, dark gray (10YR 4/1) moist; weak medium subangular blocky structure; slightly hard, very friable; few very fine roots; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk3—26 to 31 inches; light gray (2.5Y 7/2) fine sandy loam, grayish brown (2.5Y 5/2) moist; weak medium subangular blocky structure; slightly hard, very friable; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—31 to 47 inches; light brownish gray (2.5Y 6/2) loamy very fine sand, grayish brown (2.5Y 5/2) moist; few fine faint yellowish brown (10YR 5/6) mottles; single grain; loose; few fine dark stains (manganese oxide); slight effervescence; moderately alkaline; gradual wavy boundary.

C2—47 to 60 inches; light yellowish brown (2.5Y 6/4) loamy very fine sand, olive brown (2.5Y 4/4) moist; many fine faint yellowish brown (10YR 5/6) and gray (10YR 6/1) mottles; single grain; loose; few fine dark stains (manganese oxide); mildly alkaline.

The mollic epipedon is 7 to 16 inches in thickness. The A horizon has value of 3 to 5 (1 to 3 moist) and chroma of 1 or 2. It is fine sandy loam, sandy loam, very fine sandy loam, or loam. The Bk horizon has value of 4 to 7 (3 to 5 moist) and chroma of 1 or 2. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 8 (4 to 7 moist), and chroma of 2 to 4.

Zahl Series

The Zahl series consists of deep, well drained soils formed in glacial till on moraines. Permeability is moderate in the subsoil and moderately slow in the underlying material. Slopes range from 6 to 35 percent.

Typical pedon of Zahl loam, in an area of Zahl-Kloten-Edgeley complex, 9 to 35 percent slopes; 1,650 feet south and 520 feet east of the northwest corner of sec. 31, T. 127 N., R. 64 W.

A—0 to 6 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak medium

subangular blocky structure parting to weak fine granular; soft, very friable; many fine and very fine roots; strong effervescence; neutral; clear wavy boundary.

Bk1—6 to 17 inches; light gray (2.5Y 7/2) loam, light olive brown (2.5Y 5/4) moist; weak medium and fine subangular blocky structure; slightly hard, very friable; common fine and very fine roots; many fine and common medium accumulations of carbonate; strong effervescence; mildly alkaline; gradual wavy boundary.

Bk2—17 to 23 inches; light gray (2.5Y 7/2) loam, light olive brown (2.5Y 5/4) moist; weak medium and fine subangular blocky structure; slightly hard, friable; common fine and very fine roots; many fine accumulations of carbonate; few pebbles; strong effervescence; moderately alkaline; gradual wavy boundary.

C—23 to 60 inches; pale yellow (2.5Y 7/4) loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, friable; few very fine roots to a depth of 35 inches; few pebbles; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 4 to 8 inches in thickness. Typically, free carbonates are at the surface.

The A horizon has hue of 10YR or 2.5Y and value of 3 to 5 (2 or 3 moist). It is loam or clay loam. The Bk horizon has value of 5 to 7 (4 to 6 moist) and chroma of 2 to 4. It is loam or clay loam. The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is loam or clay loam.

Zell Series

The Zell series consists of deep, well drained soils formed in silty glaciolacustrine sediments on glacial lake plains. Permeability is moderate. Slopes range from 0 to 25 percent.

Typical pedon of Zell silt loam, in an area of Great Bend-Zell silt loams, 4 to 9 percent slopes; 2,500 feet north and 1,320 feet east of the southwest corner of sec. 31, T. 122 N., R. 62 W.

A—0 to 6 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; moderate medium and fine granular structure; soft, very friable; slight effervescence; mildly alkaline; clear smooth boundary.

Bk1—6 to 11 inches; grayish brown (2.5Y 5/2) silt loam, dark grayish brown (2.5Y 4/2) moist; weak coarse and medium subangular blocky structure parting to weak fine granular; soft, very friable; strong effervescence; moderately alkaline; clear wavy boundary.

Bk2—11 to 18 inches; light brownish gray (2.5Y 6/2) silt loam, light olive brown (2.5Y 5/4) moist; many fine distinct yellowish brown (10YR 5/6) and gray (5Y 5/1) relict mottles; weak coarse subangular blocky structure; slightly hard, friable; few fine striations and accumulations of carbonate; violent effervescence; moderately alkaline; clear wavy boundary.

Bky—18 to 26 inches; light gray (2.5Y 7/2) silt loam, light olive brown (2.5Y 5/4) moist; many medium prominent yellowish brown (10YR 5/6) and gray (5Y 5/1) relict mottles; weak medium and fine subangular blocky structure parting to weak thin platy; slightly hard, friable; varved; few fine soft striations and accumulations of carbonate; few fine nests of gypsum; strong effervescence; mildly alkaline; gradual smooth boundary.

C—26 to 60 inches; pale yellow (2.5Y 7/4) silt loam, light yellowish brown (2.5Y 6/4) moist; many coarse prominent brownish yellow (10YR 6/6) and gray (5Y 5/1) relict mottles; massive; slightly hard, friable; varved; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 6 to 16 inches. Typically, free carbonates are at the surface, but some pedons in areas that support native grasses are leached in the upper few inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is silt loam, loam, or very fine sandy loam. Some pedons have an AC horizon. The Bk horizon has hue of 10YR or 2.5Y, value of 6 to 8 (4 to 6 moist), and chroma of 2 to 4. It is silt loam, loam, or very fine sandy loam. The C horizon has value of 6 to 8 (4 to 6 moist) and chroma of 2 to 4. It is silt loam, loam, or very fine sandy loam and is distinctly varved.

Formation of the Soils

Soil forms when chemical and physical processes act on geologically deposited or accumulated 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 accumulated and has existed since accumulation, the plant and animal life on and in the soil, the relief, and the length of time that the forces of soil formation have acted on the soil material.

Climate and plant and animal life are active factors of soil formation. They act on the parent material and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are modified 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 having genetically related horizons. Usually, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. The following paragraphs relate the factors of soil formation to the soils in Brown County.

Climate

Climate directly influences the rate of chemical and physical weathering. Brown County has a continental climate marked by cold winters and hot summers. This climate favors the growth of grasses and the resulting accumulation of organic matter in the upper part of the soil. The precipitation is sufficient to leach carbonates in most soils to an average depth of about 17 inches. The climate is generally uniform throughout the county and thus as a separate factor does not differentiate the soils within the county. Additional climatic data are given under the heading "General Nature of the County."

Plant and Animal Life

Plants, animals, insects, earthworms, bacteria, and fungi have an important effect on soil formation. They cause gains in organic matter, gains or losses in plant nutrients, and changes in soil structure and porosity. In Brown County the tall and mid prairie grasses have had more influence than other living organisms on soil formation. As a result of these grasses, the surface layer of many soils has a moderate or high content of organic matter.

Earthworms, insects, and burrowing animals help to keep the soil open and porous. Bacteria and fungi decompose plant residue, thus releasing plant nutrients.

Parent Material

Parent material is the unconsolidated organic and mineral material in which a soil forms. It determines many of the chemical and physical characteristics of the soil, such as color, texture, reaction, and consistence. The main kinds of parent material in Brown County are lacustrine deposits, glacial till, and alluvium. Also included are glacial outwash, loess, and dune sand.

Brown County is in the James River Lowland physiographic region. The eastern one-half of the county is a plain of lacustrine material. This plain is the former bed of an extensive but shallow and short-lived glacial lake known as Lake Dakota *(6)*. Lacustrine deposits are silt, clay, and sand sediments averaging about 75 feet in thickness. They were laid down by glacial meltwater on the bed of ancient Lake Dakota. The lacustrine sediments are generally distinctly varved. The varves consist of thin alternating layers of silt and clay or fine sand. The sediments are strongly calcareous and are typically moderately saline. Beotia, Great Bend, Harmony, and Aberdeen soils are typical of the silty and clayey soils that formed in lacustrine sediments. The clayey Exline and Nahon soils, which are in microlows, and many soils in basins, such as

Tonka soils, also formed in lacustrine material.

The glacial material in Brown County was derived from preglacial formations of gneiss, granite, limestone, sandstone, siltstone, and shale. The glacier ground up and mixed this material. The resultant mass is an aggregate of sand, silt, and clay and some rock fragments.

Glacial till is the main type of parent material on glacial uplands west of the lake plain and in a small area in the southeastern part of the county. The nearly level to hilly landscape has a poorly defined drainage pattern and many potholes and sloughs. In places, as much as 250 feet of glacial till overlies the shale bedrock. The glacial till is loam or clay loam that contains small fragments of shale and stones and rocks. Barnes, Svea, Forman, Peever, Williams, and Bowbells soils formed in this glacial till. In the glacial uplands west of the lake plain are a series of southwest-trending shallow basins, many of which contain small streams. These shallow basins probably formed along the edges of the ice during periods when the retreating continental glacier stopped long enough for a drainage system to develop.

Alluvium consists of sediments that have been moved or laid down by water. These sediments are on flood plains and terraces along streams. Although they have been sorted, for example, by moving water, they generally have a rather narrow range in texture. The flood plains are along the major streams, such as the James, Elm, and Maple Rivers and Mud and Moccasin Creeks. Harriet, LaDelle, Lamoure, Ludden, Playmoor, and Ranslo soils formed in alluvium deposited by these streams.

Glacial outwash consists of sand, gravel, and loamy material deposited by glacial meltwater. As the ice melted, streams formed on the superglacial till and along the edges of the glacier. These streams deposited coarse material along the channels. Fordville and Renshaw soils formed in this gravelly alluvium.

Loess consists of uniform silty sediments laid down by wind. The area of loess in Brown County is on the east side of Lake Dakota in the southeastern part of the county. The silty material probably was derived from the lacustrine sediments to the northwest. The area is well dissected by drainageways. Kranzburg and Brookings soils formed in loess.

Dune sand and eolian sandy sediments, derived from the lacustrine material, are prominent in the northeastern part of the county. Serden, Hecla, Hamar, Swenoda, and Ulen soils are examples of soils that formed in these sediments.

Relief

Relief affects soil formation through its effect on drainage, runoff, erosion, plant cover, and soil temperature. On the more sloping soils, such as Buse soils, much of the rainfall is lost through runoff. As a result of the excessive runoff, a limited amount of moisture penetrates the surface and much of the soil material is lost through erosion. These soils have a thin surface layer and are calcareous at or near the surface.

On the less sloping soils, such as Barnes and Forman soils, runoff is slower and more rainfall penetrates the surface. These soils are calcareous at a greater depth than the Buse soils. Also, the layers in which organic matter accumulates are thicker.

Bowbells and Svea soils are on foot slopes and receive extra moisture in the form of runoff from adjacent soils. The layers in which organic matter accumulates are thicker in these soils than those in the Barnes and Williams soils. Also, calcium carbonate is leached to a greater depth. In low areas where drainage is impeded, the fluctuating water table favors the concentration of salts in the Harriet and the Vallers, saline, soils and in other soils. Parnell and Tonka soils are in basins where water ponds. They have colors that are characteristic of poorly drained soils.

Time

The length of time that soil material has been exposed to the other four factors of soil formation is reflected in the kinds of soil that form. Generally, the degree of profile development reflects the age of a soil. The oldest soils are on the parts of the landscape that have been stable for the longest time. The oldest soils in Brown County are the Barnes, Forman, Peever, and Williams soils. The youngest soils either are those in which natural erosion removes nearly as much soil material as is formed through the weathering of parent material or are alluvial soils, which receive new material each time they are flooded. Buse and Zell soils are examples of young soils that are subject to natural erosion. Lamoure soils are an example of young soils that formed in alluvium.

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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.

Argillic horizon. A subsoil horizon characterized by an accumulation of illuvial clay.

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
Very high	more than 12

Back slope. The slope component that is the steepest, straight to concave or merely concave middle portion of an erosional slope.

Basin. A depressed area with no surface outlet. Examples: closed depressions in a glacial till plain; lake basin.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Blowout. A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

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.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles 2 millimeters to 38 centimeters (15 inches) long.

Complex slope. Irregular or variable slope. Planning or establishing terraces, diversions, and other water-control structures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil 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.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

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.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on

the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.
Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.
Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Esker (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Excess salt (in tables). Excess water-soluble salt in the soil that restricts the growth of most 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.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. It has the lowest bulk density and the highest water content at saturation of all organic soil material.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

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 as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Green manure crop. (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water. (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the

identification of soil horizons, an 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.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

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.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Lake plain. A major landform that is nearly level and consists of well sorted, fine textured, stratified bottom sediment of an extinct lake.

Landform. Any physical, recognizable form or feature of the earth's surface that has a characteristic shape and is produced by natural causes.

Landscape. All the natural features, such as fields, hills, forests, and water, that distinguish one part of the earth's surface.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

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.

Mollic epipedon. A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of 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.

Natric horizon. A special kind of argillic horizon that contains enough exchangeable sodium to adversely affect the physical condition of the subsoil.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

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.

Overland flow. Shallow runoff water standing or flowing during or shortly after rainfall or snowmelt from adjacent or surrounding slopes.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Pasture, tame. Grazing land planted to primarily introduced or domesticated native forage species that receives periodic renovation or cultural treatment, such as tillage, fertilization, mowing, weed control, or irrigation.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and

alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plain. A flat, level to gently sloping or undulating area, large or small, that includes few prominent hills or valleys.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range in 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:

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

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 underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shoulder slope. The convex slope component at the top of an erosional side slope.

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.

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. The slope classes recognized in this survey are as follows:

Level	0 to 1 percent
Level and nearly level	0 to 2 percent
Very gently sloping or gently undulating	1 to 3 percent
Gently sloping or undulating	2 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 or very hilly	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.

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 underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded and 6 to 15 inches (15 to 38 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Breaking up a compact subsoil by pulling a special chisel through the soil.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Summit. The top or highest level of an upland landscape feature. A high interfluve area that is flanked by steeper hill slopes.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost, gently inclined surface at the base of a hill slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland. Land at a higher elevation, in general, than the alluvial plain or low stream terrace.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Varve. A sedimentary layer of a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in a glacial lake or other body of still water in front of a glacier.