



United States  
Department of  
Agriculture

Natural  
Resources  
Conservation  
Service

In cooperation with  
University of Nebraska  
Conservation and Survey  
Division

# Soil Survey of Sheridan County, Nebraska





# How to Use This Soil Survey

## General Soil Map

The general soil map, which is a color map, 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.

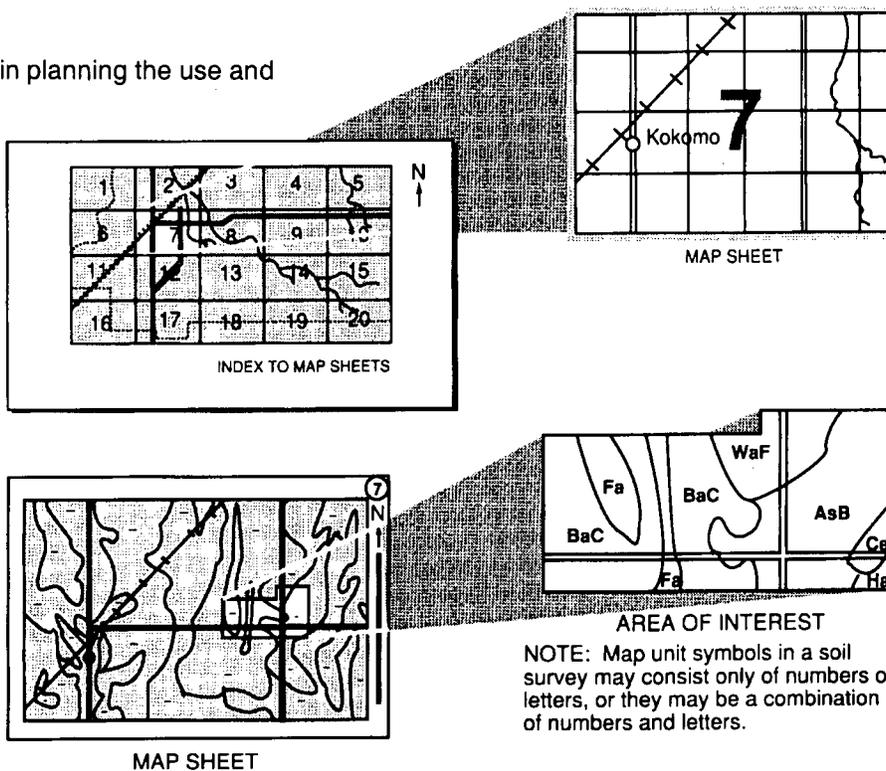
## Detailed Soil Maps

The detailed soil maps 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**. Note the number of the map sheet and turn to that sheet.

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units**, 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 the **Contents** for other sections of this publication that may address your specific needs.



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

Major fieldwork for this soil survey was completed in 1990. Soil names and descriptions were approved in 1992. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1992. This survey was made cooperatively by the Natural Resources Conservation Service and the University of Nebraska Conservation and Survey Division. The survey is part of the technical assistance furnished to the Upper Niobrara-White Natural Resource District. The Upper Niobrara-White Natural Resource District provided financial assistance to employ a soil scientist to accelerate completion of the soil survey.

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

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**Cover: Beaver Wall in northern Sheridan County. The Thirtynine soils in the areas below the wall are used as rangeland.**

*Additional information about the Nation's natural resources is available on the Natural Resources Conservation Service home page on the World Wide Web. The address is <http://www.nrcs.usda.gov> (click on "Technical Resources").*

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# Foreword

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

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

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

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

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# Soil Survey of Sheridan County, Nebraska

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United States Department of Agriculture, Natural Resources Conservation Service,  
in cooperation with the  
University of Nebraska Conservation and Survey Division

SHERIDAN COUNTY is in the northwestern part of Nebraska (fig. 1). The total land area is about 1,582,189 acres, or about 2,472 square miles. The county is about 36 miles wide from east to west and about 69 miles long from north to south. It is bordered on the north by Shannon County, South Dakota; on the east by Cherry County, Nebraska; on the south by Garden County, Nebraska; and on the west by Box Butte and Dawes Counties, Nebraska.

According to the 1990 census, the population of Sheridan County is 6,733. Rushville, the county seat, has a population of 1,217, and Gordon, the largest town, has a population of 2,245.

Sheridan County generally has good transportation facilities. The towns in the northern part of the county are served by the Nebkota Railroad, which follows U.S. Highway 20 between Merriman in Cherry County and Chadron in Dawes County. The Burlington Northern Santa Fe Railroad follows State Highway 2 in the southern part of the county. State Highways 27, 250, and 87 run north and south through the county. Many improved county roads are in the northern part of the county. Few roads are in the sandhills. Gordon, Rushville, and Hay Springs have airfields for small, private aircraft. Commercial air transportation is available at Chadron in Dawes County.

The general economy of the county is based primarily on cattle ranching and the production of hay, winter wheat, and irrigated corn. Most of the employment in the county is in farming and ranching or businesses related to agriculture.

About 70 percent of the county is rangeland and

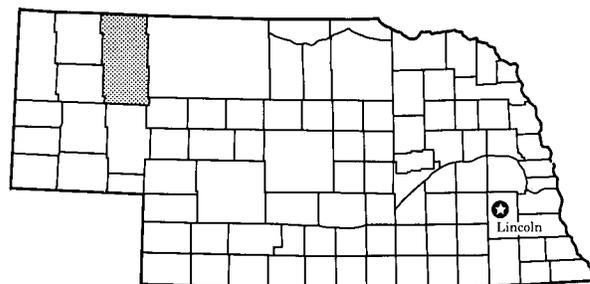


Figure 1.—Location of Sheridan County in Nebraska.

about 23 percent is cropland. Most of the cropland is dry-farmed. About 20 percent of the cropland is irrigated. Some of the areas that are dry-farmed do not have a suitable source of ground water for irrigation.

This soil survey updates the survey of Sheridan County published by the U.S. Department of Agriculture in 1921 (7). It provides a more detailed soil survey on aerial photography and contains more interpretive information.

## General Nature of the County

This section provides information about history and development; physiography, relief, and drainage; geology; ground water; and climate of Sheridan County.

## History and Development

In the summer of 1874 the Army established Camp Sheridan, named after General Phil Sheridan, near the Spotted Tail Indian Agency (7). At that time few settlers were in the area that would later become Sheridan County. In 1878 the first permanent settlement in Sheridan County was established along White Clay Creek. The first settlers were open range cattlemen who wanted to take advantage of the lush grasses in the sandhills and gold seekers on their way to the gold fields in the Black Hills of South Dakota. The completion of the railroad in 1885 brought more settlers seeking homesteads under the public land laws. Conflicts were common between the settlers and the open range cattlemen until the Herd Law of 1887 ended open range grazing by the cattlemen.

Settlements and towns were quickly established, and Sheridan County was established in 1885. The towns of Gordon, Hay Springs, and Rushville were established that year along the railroads, and farming prospered in the county. Rushville was narrowly voted in as the county seat over Hay Springs. The towns of Antioch, Hoffland, and Lakeside developed around the potash industry in the southern part of the county. For a short time during World War I this potash operation was the largest in the country.

The census of 1890 showed a population of 8,687 in Sheridan County. The 1930 census showed the county's population had grown to 10,793. Since that time the county has seen a steady decline to the current total of 6,733, according to the 1990 census. In 1910 the entire population was rural. Today about 53 percent is urban, and about 47 percent is rural. Cattle ranching remains the largest enterprise in the county.

## Physiography, Relief, and Drainage

Sheridan County lies in the High Plains region of the Great Plains. The county can be subdivided into four major landform groups. The part of the county south of the Niobrara River, or about 60 percent of the total area of the county, is part of the sandhills. About a third of the county north of the Niobrara River to the Pine Ridge escarpment is a tableland that dips to the southeast. This tableland makes up the highest and most nearly level land in the county. It is a remnant of the High Plains and is a transitional area between the sandhills and the Pine Ridge escarpment on its northwestern edge. In the extreme northwest corner of the county is the Chadron Dome, which exposes the oldest geologic materials.

Except for the northwestern part, the entire county is drained by the Niobrara River and its tributaries. Hay

Spring, Rush, and Antelope Creeks are tributaries of the Niobrara River from the tableland to the north. They have intermittent flow, depending on surface runoff and the time of year. Their stream gradients are gradual to the southeast, their flow is slow, and their flood plains are relatively wide.

The tributaries of the Niobrara River from the south, except for Box Butte Creek, drain the sandhills. Box Butte Creek drains the area of loamy soils west of the sandhills. Underground seepage keeps the flow fairly constant throughout the year. In low valleys of the sandhills water accumulates in lakes and ponds. The soils in basins that have no outflow from these lakes and ponds are slightly alkaline to strongly alkaline. Smith Lake has an outlet near Pine Creek, which allows drainage and an inflow of fresh water.

Streams in the northwestern part of the county drain into the White River. The largest tributaries of the White River in Sheridan County are Beaver, White Clay, and Wounded Knee Creeks. These streams have a steep gradient and are actively deepening their channels.

The elevation in the county ranges from about 4,000 feet north of Hay Springs near the northwest breaks called the Pine Ridge to about 3,500 feet where the Niobrara River exits the county to the east.

## Geology

Jim Kearney, geologist, Natural Resources Conservation Service, prepared this section.

The oldest exposed rocks in Sheridan County are the Carlile Shale, the Niobrara Formation, and the Pierre Shale of the Cretaceous period. These units are in a small area of about 25 square miles in the extreme northwest corner of the county. The Niobrara Formation, which consists of chalk, calcareous shale, and limestone, is the most extensive of the units.

In other areas of the county, from oldest to youngest, Tertiary rocks of the White River Group; the Chadron and Brule Formations; the Gering, Monroe Creek, and Harrison Formations of the Arikaree Group; and the Ogallala Group form the bedrock. The Brule Formation and the formations of the Arikaree Group crop out or are near the surface throughout much of the northern fourth of the county. Topographically, this area is the steeply eroded, northwest-facing slope of the Pine Ridge. The Brule Formation is pinkish to brownish siltstone and sandy siltstone containing occasional sandstone beds. It is believed to have formed mainly from wind-deposited silt made up mainly of shards and fragments of volcanic glass. The Gering Formation is mainly buried

valley and small channel deposits of grayish, very fine- to medium-grained sandstones. The overlying beds of the Monroe Creek and Harrison Formations are pale brownish, very fine and fine, silty sandstone and sandy siltstone containing calcareous nodules and concretions. Much of the material in these beds may have been deposited by the wind.

The Ogallala Group of Miocene (later Tertiary) age forms the bedrock in the extreme northeastern corner and the southern three-fourths of the county. It extends south of a line roughly about 12 miles north of and parallel to the Niobrara River. Originating from an ancient flood plain and from stream deposits of quartz, feldspar, and rock fragments from mountains to the west, the rocks in the Ogallala Group have lithologies varying among silty and silty clay sandstones, sandy and clayey siltstones, caliche limestones, and sand and gravel. Cementation is by carbonates, compaction of the silt and clay matrix, and clay weathered from feldspars and other mineral fragments. The colors of the rocks include gray, greenish-gray, brown, and white. The thickness of the Ogallala Group is more than 350 feet in the area where it fills an east-west trending paleovalley across central Sheridan County.

Deformation associated with the uplifts of the mountains to the west and the Black Hills to the north has profoundly influenced the geology in Sheridan County. The Chadron Arch, which crosses the subsurface from southeast to northwest near the center of the county, forms the eastern edge of the Denver-Julesburg structural basin to the southwest. Folding and faulting has influenced the positioning of the bedrock units, the erosion exposing them, and the drainage features in the county.

Unconsolidated Quaternary deposits are generally less than 50 feet thick in the northern part of the county north and west of the Nebraska Sandhills that mainly border the Niobrara River. In parts of the Niobrara River valley these deposits are more than 100 feet thick. These sediments occupy a limited area on the uplands and are formed by wind-deposited silt and sand along with slope wash. In the stream valleys sandy and silty alluvial deposits form relatively flat flood plains and terraces.

In the extreme northeastern corner of the county and southward from near the Niobrara River, the Quaternary deposits include bedded sequences of locally silty sand and gravel, silty and clayey sands, silt, and clayey silt that are predominantly fluvial in origin. These deposits are overlain by young dune sand that is predominantly fine sand in a variety of sand dune, interdune, and sand sheet configurations that are more than 200 feet thick.

## Ground Water

Jim Kearney, geologist, Natural Resources Conservation Service, prepared this section.

Ground water is the primary source of water for all uses in Sheridan County. In the northern part of the county, rocks are the primary water-bearing formations. The White River Group is a relatively poor source of water. Locally, its Chadron Formation contains small amounts of water in sandstone and gravel beds, but water quality is often poor. The Brule Formation also is an undependable source of water, although some joints, fractures, or faults in the fine-grained siltstone, as well as some sandstone beds, yield enough water for livestock and domestic uses.

The Arikaree and Ogallala Groups form the major aquifers in northern Sheridan County. At the base of the Arikaree Group, the Gering Formation contains permeable sand and sandstone that provide water for nearly any use. The thicker Monroe Creek and Harrison Formations above the Gering Formation are formed by the less permeable silty, fine-grained sandstone and sandy siltstone that generally supply water only for livestock or domestic uses. The Arikaree Group contains a large amount of water because it has a saturated thickness of as much as 450 feet. This Group is a complex system of paleovalley deposits with a considerable thickness of fine-grained rocks; therefore, it yields a large amount of water only if a thick interval of the saturated upper formation is penetrated or if the interval includes a thickness of the basal sandstone.

The Ogallala Group contains the most permeable rocks in northern Sheridan County and, in places, is a major source of water. The grain size, sorting, fabric, cementation of the rocks, and complex interbedding can influence the efficiency and usefulness of the Ogallala Group as an aquifer.

The complex structural geology of northern Sheridan County affects the occurrence of ground water in the bedrock. Because of tilted beds and faults, the continuity of deposits is interrupted, thus influencing the occurrence, direction, and rate of movement of ground water in permeable rocks. However, joints and fractures enhance storage and movement of water in otherwise relatively impermeable masses of rock.

The unconsolidated Quaternary alluvium forms the stream terraces and flood plains in the Niobrara River valley and the smaller stream valleys in northern Sheridan County. It provides aquifers that yield small quantities of water for livestock and domestic uses, especially in areas of coarse-grained alluvium.

The configuration of the water table in northern Sheridan County is affected by topography. The Pine Ridge separates two distinctly different gradients and shapes in the water table. In the northwestern part of the county north of the Pine Ridge, the gradient is apparently steep and generally north-northwest, reflecting the relatively steep topography and low permeable rocks. The general configuration has local variations because of the topographically high outlines from the Pine Ridge. South of the Pine Ridge, the gradient is less steep and is in an easterly direction, reflecting more subdued topography and the presence of more permeable rocks, such as the Ogallala Group. In the northeastern part of the county, where the Pine Ridge is subdued, the ground water divide is also less prominent and trends east-southeast. The actual shape of the ground water table throughout the northern part of the county is quite complicated because of the many extremes in topography, geologic structure, stratigraphy, tilt of the beds, and hydraulic conductivity. The source of ground water in the area is local precipitation. Discharge to the north of the Pine Ridge is mainly through the stream systems. South of the Pine Ridge, discharge is to stream systems, ponds, and the Niobrara River, which is a principal area of ground water discharge.

The occurrence of ground water south of the Niobrara River differs from that in the northern part of the county. The main aquifers are the Ogallala Group and the unconsolidated Pliocene through Quaternary alluvial sediments. The Ogallala Group is the oldest and thickest aquifer and ranges from about 300 to more than 700 feet thick. The dune sand that mantles southern Sheridan County is extremely important in the total hydrology of the area but does not yield large quantities of water.

Southern Sheridan County is underlain by a shallow ground water mound that extends into parts of Cherry, Grant, Garden, and Morrill Counties. Ground water flows outward from the mound in all directions. The source of the ground water is precipitation that is rapidly absorbed by the sand or flows as runoff to the numerous lakes and valleys in the sandhills. Little, if any, surface water normally flows out of southern Sheridan County. The interaction among precipitation, the hydrology of the lakes and wetlands, and ground water is complicated and not completely understood. The hydraulic connection between the lakes and ground water apparently varies from lake to lake.

Conditions of the aquifers and ground water throughout Sheridan County are complex, but the quantity and quality of the water is good for most uses.

## Climate

In Sheridan County, winters are cold because of incursions of cold, continental air that bring fairly frequent spells of low temperatures. Summers are hot but occasionally are interrupted by cooler air from the north. Snowfall is fairly frequent in winter, but the snow cover is usually not continuous. Rainfall is heaviest in late spring and early summer. The annual precipitation is normally adequate for wheat, sorghum, and range grasses.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Hay Springs in the period 1951 to 1987. 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 26 degrees F and the average daily minimum temperature is 13 degrees. The lowest temperature on record, which occurred at Hay Springs on January 19, 1963, is -31 degrees. In summer, the average temperature is 70 degrees and the average daily maximum temperature is 85 degrees. The highest recorded temperature, which occurred on July 6, 1963, is 110 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 20 inches. Of this, 15 inches, or 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 13 inches. The heaviest 1-day rainfall during the period of record was 4.15 inches at Hay Springs on June 20, 1965. Thunderstorms occur on about 44 days each year.

The average seasonal snowfall is 57 inches. The greatest snow depth at any one time during the period of record was 26 inches. On the average, 20 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 50 percent. Humidity is higher at night, and the average at dawn is about 75 percent. The sun shines 70 percent of the time possible in summer and 60 percent in winter. The prevailing wind is from the

northwest. Average windspeed is highest, 13 miles per hour, in spring.

Severe duststorms occur occasionally in the spring, when strong, dry winds blow across unprotected soils. Tornadoes and severe thunderstorms, some of which are accompanied by hail, occur occasionally. These storms are local in extent and of short duration. The damage is variable and spotty.

## How This Survey Was Made

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

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

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

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots,

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

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

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

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

## Map Unit Composition

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

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

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be

mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are named and 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

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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.

Some soil boundaries and soil names in this survey do not fully match those in the surveys of adjoining counties that were published at an earlier date. Differences are the result of changes and refinements in series concepts, variations in slope groupings, and application of the latest classification system.

## Soil Descriptions

### Areas of Soils Formed in Material Weathered from Interbedded Chalk and Shale or from Siltstone and Areas of Rock Outcrop

Two associations are in this group. These soils formed in material weathered from interbedded chalk and shale or siltstone. Most of the acreage of the soils in this group supports native grasses used for range. The rest is cultivated. Soil blowing and water erosion are the principal hazards. Regulating the timing and intensity of grazing and improving the range condition are the principal concerns affecting rangeland.

Improving fertility and controlling soil blowing are the main concerns affecting cultivated areas.

#### 1. Enning-Rock outcrop-Minnequa association

*Areas of Rock outcrop and shallow and moderately deep, gently sloping to very steep, well drained, silty soils; on uplands*

This association is in the northwestern corner of the county, which is known locally as the Chadron Dome. It consists of gently sloping to very steep side slopes and ridges and broad, gently sloping foot slopes. Rough, broken side slopes and escarpments are along some of the deeply entrenched drainageways. Runoff flows toward the White River.

This association makes up about 19,840 acres, or about 1 percent of the county. It is about 38 percent Enning soils, 23 percent areas of Rock outcrop, 12 percent Minnequa soils, and 27 percent minor soils.

The strongly sloping to very steep Enning soils are on ridgetops and breaks adjacent to intermittent drainageways. They are shallow and well drained. They formed in material weathered from interbedded chalk and shale. Typically, the surface layer is grayish brown, friable, calcareous silty clay loam about 3 inches thick. The transitional layer is light brownish gray, friable, calcareous silty clay loam about 4 inches thick. The underlying material is light gray, friable, calcareous silty clay loam to a depth of 18 inches. Below a depth of 18 inches is interbedded chalk and shale.

The areas of Rock outcrop are on the dissected side slopes and escarpments of upland breaks and deeply entrenched drainageways. Rock outcrop is weathered, interbedded limestone and shale.

The gently sloping to steep Minnequa soils are on the smoother side slopes of the uplands. These soils are moderately deep and well drained. They formed in material weathered from interbedded chalk and shale. Typically, the surface layer is grayish brown, friable,

calcareous silty clay loam about 4 inches thick. The transitional layer is light brownish gray, friable, calcareous silty clay loam about 6 inches thick. The underlying material extends to a depth of 33 inches. The upper part is light brownish gray, friable, calcareous silty clay loam. The lower part is light gray, very friable, calcareous silt loam. Below a depth of 33 inches is interbedded chalk and shale.

Of minor extent in this association are Bufton and Manvel soils. The very deep Bufton soils are on high upland divides and on stream terraces and foot slopes. The very deep Manvel soils are on foot slopes and stream terraces and formed in colluvial and alluvial outwash material from the surrounding uplands.

Nearly all of this association supports native grasses and is used for grazing. Nearly all of the acreage is used for feeder calf operations. A small area of the gently sloping soils is cultivated, and dryland wheat and alfalfa are the main crops.

The major soils in this association contain selenium, and livestock that graze continuously in the area are subject to selenium poisoning. Insufficient seasonal rainfall limits the growth of grasses. An inadequate supply of water for livestock limits grazing. Precipitation that accumulates in stock-water ponds is the only source of water for livestock except in areas served by pipelines. Wells yield low quantities of water that has a high mineral content. Some of this water is not suitable for domestic use.

Water erosion and soil blowing are hazards affecting cultivated areas. The soils are low in natural fertility.

Very few ranch headquarters are in this association. Trails supplement the one unimproved dirt road that crosses part of the area. Ranch products are marketed locally.

## **2. Thirtynine-Kadoka-Epping association**

*Very deep, moderately deep, and shallow, nearly level to very steep, well drained, silty and loamy soils; on uplands*

This association is between the Pine Ridge and the Chadron Dome. It consists mainly of nearly level to very steep ridgetops, side slopes, and breaks along creeks and intermittent drainageways. The creeks originate mainly in the Pine Ridge area and flow north toward the White River.

This association makes up about 30,720 acres, or about 2 percent of the county. It is about 27 percent Thirtynine soils, 22 percent Kadoka soils, 19 percent Epping soils, and 32 percent minor soils.

The nearly level to strongly sloping Thirtynine soils are on broad ridgetops and side slopes. These soils are very deep and well drained. They formed in loamy material weathered from siltstone. Typically, the surface layer is grayish brown, friable loam about 8 inches thick. The subsoil is 17 inches thick. The upper part is brown and light brownish gray, firm silty clay loam. The lower part is light gray, friable, calcareous silt loam. The underlying material is very pale brown, calcareous very fine sandy loam to a depth of more than 60 inches.

The nearly level to strongly sloping Kadoka soils are on broad ridgetops and side slopes. These soils are moderately deep and well drained. They formed in silty material weathered from siltstone. Typically, the surface layer is grayish brown, friable silt loam about 7 inches thick. The subsoil is about 20 inches thick. The upper part is brown, friable silty clay loam; the middle part is pale brown, friable silt loam; and the lower part is very pale brown, friable, calcareous silt loam. The underlying material is very pale brown, calcareous silt loam to a depth of 32 inches. Below a depth of 32 inches is very pale brown, bedded siltstone.

The gently sloping to very steep Epping soils are on narrow ridgetops and breaks along intermittent drainageways. These soils are shallow and well drained. They formed in loamy sediments weathered from siltstone. Typically, the surface layer is light brownish gray, very friable very fine sandy loam about 3 inches thick. The transitional layer is pale brown, very friable, calcareous very fine sandy loam about 3 inches thick. The underlying material is very pale brown, calcareous very fine sandy loam to a depth of 15 inches. Very pale brown siltstone is below a depth of 15 inches.

Of minor extent in this association are Bufton, Orella, Mitchell, and Bridget soils. Bufton soils are very deep and are on broad ridgetops and side slopes. Orella soils are shallow and are on side slopes. Mitchell soils are very deep and are on moderately steep and steep side slopes. Bridget soils are very deep and are on foot slopes in the Pine Ridge area and on stream terraces. They formed in colluvial and alluvial outwash material from the surrounding uplands.

Farms in this association are diversified. Most of the farms are cash-grain and livestock enterprises. Most of the acreage of the soils in this association supports native grasses and is used for grazing or hay. The main livestock enterprise is the production of beef cattle. About 40 percent of this association is cultivated. Dryland wheat, millet, and alfalfa are the principal crops.

### **Areas of Soils Formed in Material Weathered from Calcareous Sandstone and Areas of Rock Outcrop; in the Pine Ridge Area**

Only one association is in this group. The soils formed in material weathered from calcareous sandstone in the Pine Ridge. Nearly all of the acreage of the soils in this group support native grasses and woodland and are used mainly for grazing. Soil blowing and water erosion are the principal hazards. Regulating the timing and intensity of grazing and improving the range condition are the principal concerns affecting range. Improving woodland management by thinning stands to release growing stock trees is a concern. Improving fertility and controlling soil blowing are the main concerns affecting cultivated areas.

### **3. Tassel-Ponderosa-Rock outcrop association**

*Areas of Rock outcrop and shallow and very deep, strongly sloping to very steep, well drained, loamy soils; on uplands*

This association is in the northern part of the county and is known locally as the Pine Ridge. It consists mainly of steep and very steep side slopes, ridges, and breaks that are covered with ponderosa pine. Many areas of rock outcrop, canyon walls, and escarpments are in this area. The rest of the area is strongly sloping to steep.

This association makes up about 137,600 acres, or about 9 percent of the county. It is about 40 percent Tassel soils, 30 percent Ponderosa soils, 11 percent areas of Rock outcrop, and 19 percent minor soils (fig. 2).

The strongly sloping to very steep Tassel soils are on ridgetops, on breaks adjacent to intermittent drainageways, and on side slopes of valleys and canyons. They are shallow and well drained. They formed in loamy material weathered from calcareous sandstone. Typically, the surface layer is pale brown, very friable, calcareous very fine sandy loam about 4 inches thick. The underlying material is very pale brown, calcareous very fine sandy loam to a depth of 14 inches. Below a depth of 14 inches is very pale brown, calcareous sandstone.

The strongly sloping to very steep Ponderosa soils are on the middle and lower side slopes. They are very deep and well drained. They formed in sandy and loamy sediments weathered from calcareous sandstone. Typically, the surface layer is grayish

brown, very friable very fine sandy loam about 12 inches thick. The transitional layer is pale brown, very friable very fine sandy loam about 9 inches thick. The underlying material to a depth of more than 60 inches is light brownish gray very fine sandy loam in the upper part and very pale brown, calcareous loamy very fine sand in the lower part. Sandstone fragments are common throughout the underlying material.

Areas of Rock outcrop are on narrow upland divides and along upland breaks, escarpments, and canyon walls. It is the steepest part of the landscape. Rock outcrop consists of calcareous sandstone.

Of minor extent in this association are Jayem, Oglala, Munjor, and Vetal soils. Jayem and Oglala soils are on ridgetops and side slopes on uplands. Munjor soils are on bottom land along streams flowing out of the Pine Ridge area. Vetal soils are on foot slopes of the Pine Ridge.

Nearly all of this association supports native grasses and woodland and is primarily used for grazing. Most of the areas are generally too steep for cultivation. The shallow Tassel soils limit root development. Some of the more gently sloping soils on some broad ridgetops and foot slopes are cultivated. Dryland wheat and alfalfa are the main crops and are used mainly as winter feed for livestock.

The steep and very steep topography, the areas of Rock outcrop, and the shallow soils limit the use of most areas of this association to range, woodland, recreational areas, and wildlife habitat. This area provides good recreational sites and excellent habitat for deer, turkey, and other upland wildlife. It has good potential for the further development of wildlife habitat and recreational sites. Most of the association supports ponderosa pine and has good potential for commercial timber production.

Water erosion and soil blowing are the main hazards affecting cultivated areas. A system of conservation tillage that keeps protective amounts of crop residue on the surface and the use of cover crops help to control soil blowing and conserve moisture. The use of these soils as range effectively helps to control erosion. Proper grazing use, timely deferment of grazing, and a planned grazing system help to maintain or improve the range condition. Proper woodland management that improves the forest stands is a concern.

### **Soils Formed in Loess and Material Weathered from Calcareous Sandstone**

Five associations are in this group. The soils formed in material weathered from calcareous sandstone, loamy and sandy eolian material, or local loamy

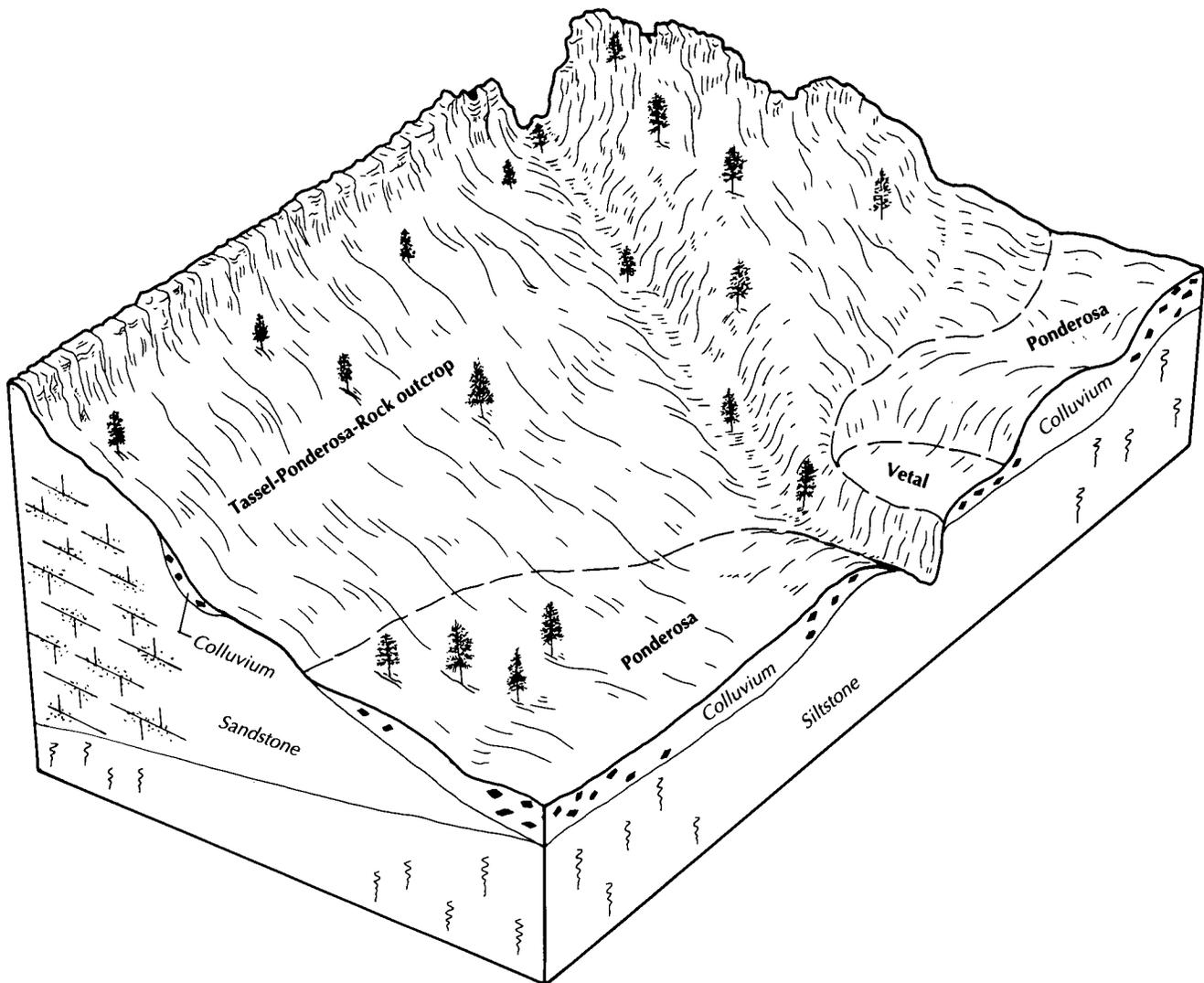


Figure 2.—Typical pattern of soils and parent material in the Tassel-Ponderosa-Rock outcrop association.

alluvial sediment on uplands. Most of the acreage of the soils in this group are cultivated. The rest supports native grasses used for grazing. Soil blowing and water erosion are the principal hazards.

#### 4. Oglala-Alliance-Canyon association

*Deep and shallow, nearly level to steep, well drained, loamy soils; on uplands*

This association consists of nearly level to steep side slopes, ridgetops, and shoulders of uplands. It is on some of the highest elevations in the county and makes up the drainage divide between the White River to the north and the Niobrara River to the south.

This association makes up about 133,760 acres, or about 8 percent of the county. It is about 37 percent Oglala soils, 29 percent Alliance soils, 23 percent Canyon soils, and 11 percent minor soils (fig. 3).

The gently sloping to steep Oglala soils are on convex side slopes and rounded ridgetops. These soils are deep and well drained. They formed in loamy material weathered from calcareous sandstone. Typically, the surface layer is grayish brown, friable loam about 8 inches thick. The transitional layer is grayish brown, friable silt loam about 11 inches thick. The underlying material to a depth of 58 inches is light brownish gray, calcareous silt loam in the upper part and light gray, calcareous loam in the lower part.

Below a depth of 58 inches is white, calcareous sandstone.

The nearly level to gently sloping Alliance soils are on side slopes and broad ridgetops. These soils are deep and well drained. They formed in loess and the underlying calcareous sandstone. Typically, the surface layer is dark grayish brown, friable loam about 8 inches thick. The subsoil is about 15 inches thick. The upper part is grayish brown, firm silty clay loam; the middle part is pale brown, firm silty clay loam; and the lower part is pale brown, friable loam. The underlying material is light gray, calcareous very fine sandy loam to a depth of 49 inches. Below a depth of 49 inches is calcareous sandstone.

The gently sloping to steep Canyon soils are on narrow ridgetops and convex shoulders and the upper side slopes. These soils are shallow and well drained. They formed in loamy material weathered from calcareous sandstone. Typically, the surface layer is grayish brown, very friable very fine sandy loam about

5 inches thick. The transitional layer is light brownish gray, very friable loam about 5 inches thick. The underlying material is light gray very fine sandy loam to a depth of 14 inches. Below a depth of 14 inches is white, calcareous sandstone.

Of minor extent in this association are Rosebud, McCook, and Duroc soils. Rosebud soils are on landscapes similar to those of the Alliance soils and are moderately deep to bedrock. The very deep McCook soils are on bottom land and formed in recent alluvial material from the surrounding uplands. The very deep Duroc soils are on stream terraces, in upland swales, and on concave foot slopes and formed in alluvial and colluvial material.

Farms in this association are diversified, mainly a combination of cash-grain and livestock enterprises. The nearly level to strongly sloping areas generally are cultivated. The steep areas and some of the strongly sloping areas generally support native grasses and are used for grazing. The shallow Canyon soils limit

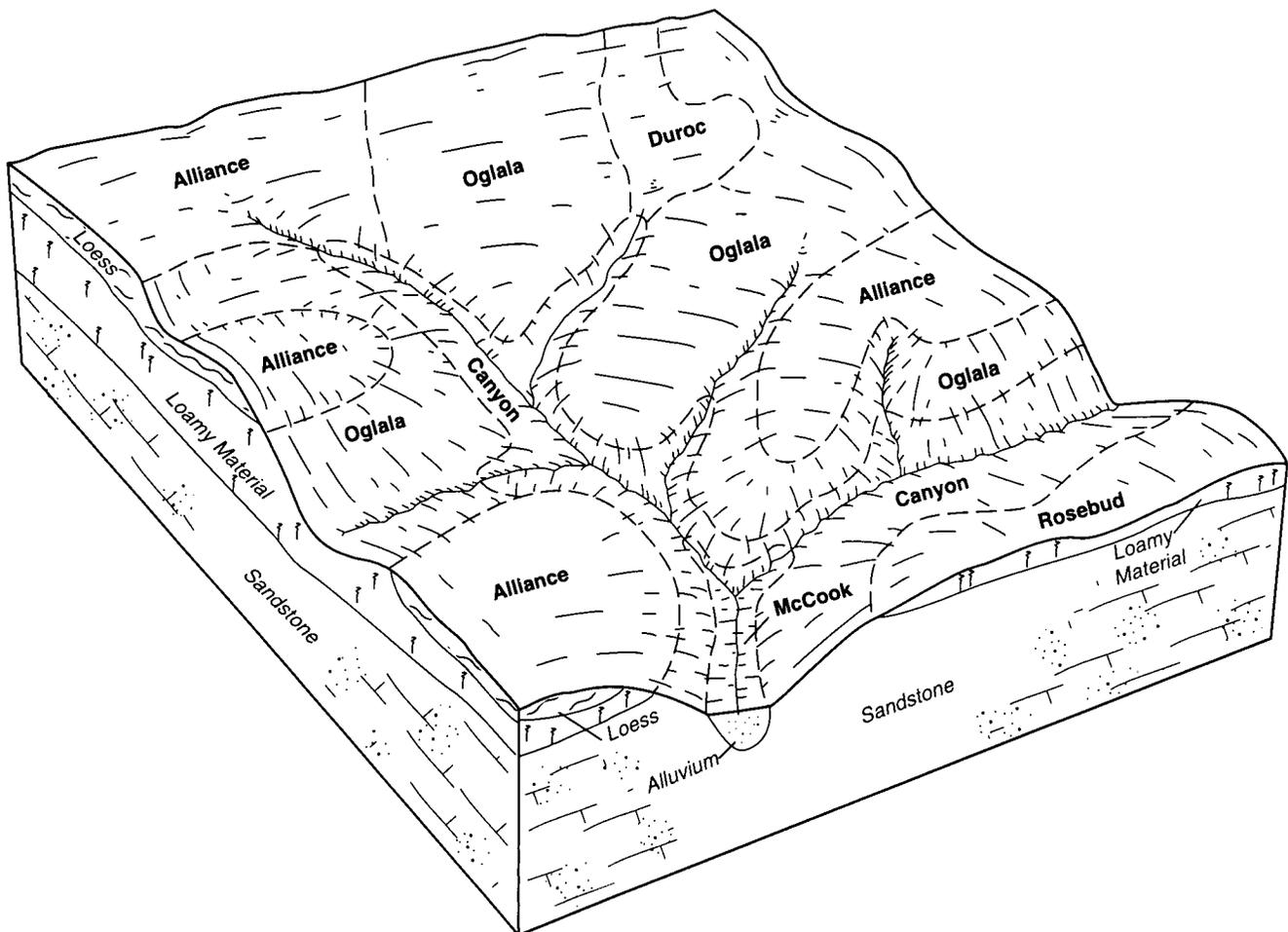


Figure 3.—Typical pattern of soils and parent material in the Oglala-Alliance-Canyon association.

root development. The main dryland crops are wheat, alfalfa, oats, and millet. A few areas are irrigated, and corn and alfalfa are the main crops.

Water erosion and soil blowing are the main hazards affecting cultivated areas. A system of conservation tillage that leaves crop residue on the surface and the use of cover crops help to control erosion and conserve moisture.

## 5. Satanta-Canyon-Busher association

*Very deep, deep, and shallow, nearly level to steep, well drained, loamy soils; on uplands*

This association consists mainly of soils on side slopes, shoulders, and ridgetops. Many areas are dissected by drainageways. Slopes range from 0 to 30 percent.

This association makes up about 71,040 acres, or about 4 percent of the county. It is about 32 percent Satanta soils, 22 percent Canyon soils, 13 percent Busher soils, and about 33 percent minor soils.

The nearly level to strongly sloping Satanta soils are on broad ridgetops and side slopes of uplands. They are very deep and well drained. They formed in loamy eolian material. Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 9 inches thick. The subsurface layer is similar to the surface layer in color and texture and is about 5 inches thick. The subsoil is about 21 inches thick. It is grayish brown and pale brown, firm sandy clay loam in the upper part and light gray, calcareous, friable loam in the lower part. The underlying material is light gray very fine sandy loam and fine sandy loam to a depth of more than 60 inches.

The gently sloping to steep Canyon soils are on narrow ridgetops, shoulders, and convex side slopes of uplands. They are shallow and well drained. They formed in loamy material weathered from calcareous sandstone. Typically, the surface layer is grayish brown, very friable loam about 5 inches thick. The transitional layer is light brownish gray, very friable loam about 5 inches thick. The underlying material is light gray very fine sandy loam to a depth of 14 inches. Below this to a depth of more than 60 inches is white, calcareous sandstone.

The nearly level to steep Busher soils are on the lower side slopes and ridgetops. They are deep and well drained. They formed in material weathered from calcareous sandstone. Typically, the surface soil is dark grayish brown and brown, very friable fine sandy loam about 10 inches thick. The subsoil is brown, very friable fine sandy loam about 8 inches thick. The

underlying material to a depth of 44 inches is pale brown fine sandy loam in the upper part and white, calcareous loamy very fine sand in the lower part. Below this to a depth of more than 60 inches is white, calcareous sandstone.

Of minor extent in this association are Alliance, Dailey, Duroc, Jayem, Keith, Keya, Lodgepole, Munjor, Tuthill, and Vetal soils. Alliance soils have calcareous sandstone bedrock at a depth of 40 to 60 inches and are on landscapes similar to those of the Satanta soils. Dailey and Jayem soils have less clay in the subsoil than the Satanta soils and are on similar landscapes. Tuthill soils have loamy fine sand or fine sand at a depth of 20 to 40 inches and are on landscapes similar to those of the Satanta soils. Keith soils have less sand in the subsoil than the Satanta soils and are on similar landscapes. Munjor and Vetal soils are coarser textured than the major soils. Keya and Duroc soils have a dark surface layer more than 20 inches thick and are lower on the landscape than the Satanta and Canyon soils. Lodgepole soils have a dark surface layer more than 20 inches thick and are in shallow depressions.

Farms in this association are diversified, with winter wheat and cattle as the main enterprises. In areas that are irrigated by a sprinkler or a gravity system, dry, edible beans; corn; and alfalfa are grown. The shallow Canyon soils limit root development for cultivated crops. Cattle and grain are marketed locally or in adjacent counties. A system of conservation tillage that keeps protective amounts of crop residue on the surface and the use of cover crops help to control erosion. Proper grazing use, timely deferment from grazing, and a planned grazing system help improve or maintain the range condition.

## 6. Tuthill-Keya association

*Very deep, nearly level to strongly sloping, well drained, loamy and sandy soils; on uplands*

This association consists of soils on uplands and in upland swales. Slopes range from 0 to 11 percent.

This association makes up 126,080 acres, or about 8 percent of the county. It is 63 percent Tuthill soils, 25 percent Keya soils, and about 12 percent minor soils.

The nearly level to strongly sloping Tuthill soils are on uplands. They are very deep and well drained. They formed in sandy and loamy material of mixed origin. Typically, the surface layer is dark grayish brown, very friable fine sandy loam or loamy fine sand about 9 inches thick. The subsoil is dark brown and brown, firm sandy clay loam about 12 inches thick. The

underlying material to a depth of more than 60 inches is pale brown loamy fine sand in the upper part and very pale brown fine sand in the lower part.

The nearly level Keya soils are in upland swales. They are very deep and well drained. They formed in local loamy alluvium. Typically, the surface layer is dark grayish brown, friable loam about 6 inches thick. The subsurface layer is similar to the surface layer in color and texture and is about 11 inches thick. The subsoil is about 32 inches thick. It is dark grayish brown and grayish brown, firm clay loam in the upper part and pale brown, friable, calcareous loam in the lower part. The underlying material is very pale brown, calcareous loam to a depth of more than 60 inches.

Of minor extent in this association are Busher, Dailey, Valent, and Vetal soils. Busher soils have calcareous sandstone bedrock above a depth of 60 inches and are on landscapes similar to those of the Tuthill soils. Dailey and Valent soils have less clay in the profile than the Tuthill soils and are on similar landscapes. Vetal soils have less clay in the profile than the Keya soils and are on similar landscapes.

Farms in this association are diversified grain and livestock enterprises. Winter wheat and alfalfa are the main crops. Some cultivated areas are planted to sunflowers and millet. Some areas support native grasses and are used as range. Grain and cattle are marketed locally or in adjacent counties. Alfalfa is used as winter feed for cattle.

Erosion is the main hazard in cultivated areas. A system of conservation tillage that keeps protective amounts of crop residue on the surface and the use of cover crops help to control erosion and conserve moisture. Proper grazing use, timely deferment of grazing, and a planned grazing system help improve or maintain the range condition.

## 7. Busher-Tassel association

*Deep and shallow, nearly level to steep, well drained, loamy soils; on uplands*

This association consists mainly of soils on ridgetops, shoulders, side slopes, and breaks on uplands. Slopes range from 0 to 30 percent.

This association makes up about 10,880 acres, or less than 1 percent of the county. It is about 38 percent Busher soils, about 20 percent Tassel soils, and about 42 percent minor soils.

The nearly level to steep Busher soils are on the lower side slopes and ridgetops. They are deep and well drained. They formed in material weathered from calcareous sandstone. Typically, the surface soil is dark grayish brown and brown, very friable fine sandy

loam about 10 inches thick. The subsoil is brown, very friable fine sandy loam about 8 inches thick. The underlying material to a depth of 44 inches is pale brown, calcareous fine sandy loam in the upper part and white loamy very fine sand in the lower part. Below this to a depth of more than 60 inches is white, calcareous sandstone.

The strongly sloping to steep Tassel soils are on shoulders and the upper side slopes on uplands. They are shallow and well drained. They formed in loamy material weathered from calcareous sandstone. Typically, the surface layer is dark grayish brown, very friable, calcareous fine sandy loam about 3 inches thick. The underlying material is light brownish gray, calcareous fine sandy loam to a depth of 10 inches. Below this to a depth of more than 60 inches is white, calcareous sandstone.

Of minor extent in this association are Canyon, Dailey, Jayem, Satanta, Valent, and Vetal soils. Canyon soils have more clay than the Tassel soils and are on similar landscapes. Dailey, Jayem, Satanta, and Valent soils do not have calcareous sandstone above a depth of 60 inches and are on landscapes similar to those of the Busher soils. Vetal soils do not have bedrock above a depth of 60 inches and are lower on the landscape than the Busher soils.

The soils in this association support native grasses and are used as range. They are not suitable for cultivation because of the slope, the shallow root zone, and the hazard of erosion. The use of these soils as range helps to control erosion. Proper grazing use, timely deferment of grazing, and a planned grazing system help improve or maintain the range condition. Livestock are sold locally or in adjacent counties.

## 8. Busher-Valent-Tassel association

*Very deep, deep, and shallow, nearly level to very steep, well drained and excessively drained, loamy and sandy soils; on uplands*

This association is on breaks, dunes, and ridges on uplands and on side slopes adjacent to upland drainageways. Most of the intermittent drainageways are tributaries of the Niobrara River.

This association makes up about 3,520 acres, or less than 1 percent of the county. It is about 27 percent Busher soils, 24 percent Valent soils, 14 percent Tassel soils, and 35 percent minor soils.

The nearly level to steep Busher soils are on smooth side slopes and ridgetops between upland drainageways. These soils are deep and well drained. They formed in material weathered from calcareous sandstone. Typically, the surface layer is very friable

fine sandy loam about 10 inches thick. It is dark grayish brown in the upper part and dark brown in the lower part. The subsoil is brown, very friable fine sandy loam about 8 inches thick. The underlying material to a depth of 44 inches is pale brown, calcareous fine sandy loam in the upper part and white, calcareous loamy very fine sand in the lower part. Below this to a depth of 60 inches is calcareous sandstone.

The nearly level to very steep Valent soils are on dunes in the sandhills. These soils are very deep and excessively drained. They formed in eolian sand. Typically, the surface layer is grayish brown, loose fine sand or loamy fine sand about 4 inches thick. The underlying material is pale brown fine sand to a depth of more than 60 inches.

The strongly sloping to steep Tassel soils are on ridgetops, breaks, and the upper side slopes along intermittent drainageways. These soils are shallow and well drained. They formed in loamy material weathered from sandstone. Typically, the surface layer is dark grayish brown, very friable, calcareous fine sandy loam about 3 inches thick. The underlying material is light brownish gray, calcareous fine sandy loam to a depth of about 10 inches. Below this to a depth of 60 inches is white, calcareous sandstone.

Of minor extent in this association are Jayem, Oglala, and Vetal soils. The nearly level to strongly sloping Jayem soils are on uplands. The gently sloping to steep Oglala soils are on side slopes on the uplands. Vetal soils are in upland swales.

This association mainly supports native grasses used for grazing. Some areas of the less sloping soils are farmed. Winter wheat is the main dryland crop, and corn and alfalfa are the main irrigated crops.

Water erosion is the principal hazard affecting areas used for range, and soil blowing is the principal hazard affecting cultivated areas. Insufficient rainfall in summer generally limits the growth of grasses and cultivated crops. A restrictive layer in some of the soils limits root growth and the available water capacity for the production of grasses and crops. Regulating the timing and intensity of grazing and improving the range condition are the principal management concerns affecting range. Controlling soil blowing and improving fertility are the management concerns affecting cultivated areas.

Farms and ranches in this association average about 2,000 acres. Many of the owners or operators live outside this association. Wells provide sufficient water for livestock and domestic uses. Cattle is the main livestock enterprise, and most cattle are marketed outside the county at local sale barns or at larger terminal markets. Some of the yearling calves

are sold directly to feeder buyers. Cash-grain crops are marketed locally. Very few improved roads are in this association. Trails provide access to most areas.

## **Areas of Soils Formed in Mixed Loess and Alluvium and Areas of Rock Outcrop**

Three associations are in this group. These soils formed in material weathered from mixed loess and alluvium on upland stream terraces and on bottom land adjacent to the Niobrara River. Most of the acreage of the soils in this group support native grasses and are used as range. Most of the soils in the Mirage Flats area are irrigated. Soil blowing and water erosion are the principal hazards affecting cultivated areas.

### **9. Keith, gravelly substratum-Bridget-Johnstown association**

*Very deep, nearly level to gently sloping, well drained, loamy soils; on uplands, foot slopes, and alluvial fans*

This association consists mainly of soils on uplands adjacent to the Niobrara River. Slopes range from 0 to 6 percent.

This association makes up about 24,960 acres, or about 2 percent of the county. It is 50 percent Keith, gravelly substratum, soils; 25 percent Bridget soils; 19 percent Johnstown soils; and about 6 percent minor soils.

The Keith, gravelly substratum, soils are nearly level to gently sloping and formed in loess over gravelly sediment on uplands. They are very deep and well drained. Typically, the surface soil is dark grayish brown, friable loam about 12 inches thick. The subsoil is about 18 inches thick. It is grayish brown, friable clay loam in the upper part and light brownish gray, friable silt loam in the lower part. The underlying material is light gray, calcareous loam to a depth of 49 inches. Below this to a depth of more than 60 inches is white, calcareous gravelly coarse sand.

The Bridget soils are nearly level and very gently sloping and formed in loamy colluvial and alluvial sediments. They are on foot slopes and alluvial fans. These soils are very deep and well drained. Typically, the surface soil is grayish brown loam about 9 inches thick. The transitional layer is light brownish gray, very friable, calcareous loam about 6 inches thick. The underlying material is calcareous, light gray loam to a depth of more than 60 inches.

The Johnstown soils are nearly level and formed in loess and loamy sediment over gravelly sand. They are on uplands. They are very deep and well drained.

Typically, the surface soil is dark grayish brown loam about 11 inches thick. The subsoil is about 26 inches thick. It is grayish brown, dark grayish brown, and pale brown, firm silty clay loam in the upper part and light gray, friable, calcareous loam in the lower part. The underlying material is light gray, calcareous loam to a depth of 43 inches. Below this to a depth of more than 60 inches is light gray, calcareous gravelly coarse sand.

Of minor extent in this association are Satanta and Beckton soils. Satanta soils are not underlain by gravelly coarse sand and are higher on the landscape than the Johnstown soils. The alkali-affected Beckton soils are lower on the landscape than the Bridget soils.

Farms in this association produce winter wheat. In irrigated areas corn and dry, edible beans are the main crops.

Water erosion and soil blowing are the main hazards. A system of conservation tillage and the use of cover crops help to control erosion and conserve moisture. Farm produce is marketed mainly within the county or in adjacent counties.

## 10. Beckton-Lute association

*Very deep, nearly level, moderately well drained and somewhat poorly drained, loamy soils; on alluvial fans and low stream terraces*

This association consists of soils on alluvial fans and low stream terraces that have a high content of sodium. Slopes range from 0 to 2 percent.

This association is about 24,320 acres, or about 2 percent of the county. It is 56 percent Beckton soils, 25 percent Lute soils, and 19 percent minor soils.

Beckton soils are very deep, moderately well drained, and nearly level. They formed in loamy alluvium. Typically, the surface layer is dark grayish brown, very friable silt loam about 5 inches thick. The subsurface layer is light gray, very friable silt loam about 3 inches thick. The subsoil is about 27 inches thick. It is grayish brown, firm silty clay loam in the upper part and brown, very friable, calcareous silt loam in the lower part. The underlying material is light gray, calcareous silt loam to a depth of more than 60 inches.

Lute soils are very deep, somewhat poorly drained, and nearly level. They formed in loamy alluvium. Typically, the surface layer is dark gray, friable loam about 6 inches thick. The subsurface layer is light brownish gray loam about 1 inch thick. The subsoil is about 17 inches thick. It is gray, firm, calcareous sandy clay loam in the upper part and grayish brown, very friable, calcareous very fine sandy loam in the lower

part. The underlying material is light gray, calcareous very fine sandy loam to a depth of more than 60 inches.

Of minor extent in this association are Busher, Calamus, Munjor, Jayem, Keya, Tryon, and Vetal soils. The minor soils do not contain sodium and are higher on the landscape than the major soils.

Nearly all of this association supports native grasses used as range or hayland. Some areas are used as cropland.

Farms in this association are diversified cattle and grain enterprises. Winter wheat is the main cultivated crop and is grown mainly in the areas that are least affected by sodium. Some alfalfa also is grown.

The use of the soils in this association as range or hayland is effective in controlling soil erosion. In cultivated areas a system of conservation tillage that keeps protective amounts of crop residue on the surface and the use of cover crops help to control water erosion and soil blowing and conserve moisture. Crops are marketed locally or in adjacent counties.

## 11. Orpha-Calamus-Rock outcrop association

*Areas of Rock outcrop and very deep, nearly level to very steep, excessively drained and moderately well drained, sandy soils; on uplands, foot slopes, and bottom land*

This association consists mainly of the valley sides and valley floor along the Niobrara River. Slopes range from 0 to 60 percent.

This association makes up about 62,080 acres, or about 4 percent of the county. It is about 48 percent Orpha soils, 15 percent Calamus soils, 14 percent areas of Rock outcrop, and about 23 percent minor soils (fig. 4).

The gently sloping to very steep Orpha soils are on side slopes and foot slopes. They are very deep and excessively drained. They formed in sandy material weathered from sandstone. Typically, the surface layer is grayish brown loamy fine sand about 6 inches thick. The transitional layer is light brownish gray sand about 4 inches thick. The underlying material is light gray sand and fine sand to a depth of more than 60 inches. It is calcareous in the lower part.

The nearly level to very gently sloping Calamus soils are on bottom land along the Niobrara River and its tributaries. They are very deep and moderately well drained. They formed in sandy alluvium and are rarely flooded. Typically, the surface layer is grayish brown loamy fine sand about 9 inches thick. The transitional layer is light brownish gray fine sand about 9 inches



Figure 4.—Typical area of the Orpha-Calamus-Rock outcrop association.

thick. The underlying material is light gray fine sand to a depth of more than 60 inches. The lower part is mottled and stratified with loamy fine sand and fine sandy loam.

Areas of Rock outcrop are in the steepest areas on the upper side slopes. Rock outcrop is calcareous sandstone.

Of minor extent in this association are Almeria, Bolent, Jayem, Lute, Tryon, and Vetal soils. Almeria soils are poorly drained and are on bottom land along the Niobrara River and Rush Creek. Bolent soils are somewhat poorly drained and are on bottom land along the Niobrara River and Rush Creek. Lute soils have a high content of sodium and are on low stream terraces and alluvial fans. Jayem, Tryon, and Vetal soils have a dark surface soil and are lower on the landscape than the Orpha soil.

The soils in this association mainly support native

grasses and are used as range. The Orpha soils are generally too steep for cultivation. The Calamus soils are subject to rare flooding and the hazard of soil blowing. Some areas of the Calamus soils are used for native hay, but in a few areas alfalfa is grown for use as winter feed. Cattle are marketed locally or in adjacent counties.

### **Soils Formed in Sandy Eolian Material and Sandy Alluvium**

Five associations are in this group. These soils formed in eolian sand and sandy alluvium in the sandhills. Nearly all of the acreage of the soils in this group support native grasses and are used as range and hayland. A few small areas are cultivated. Soil blowing is the principal hazard. Regulating the timing and intensity of grazing and maintaining or improving

the range condition are the principal concerns affecting rangeland. Soil blowing is the main management concern affecting cultivated areas.

## 12. Valent-Dailey association

*Very deep, nearly level to rolling, excessively drained and somewhat excessively drained, sandy soils; in the sandhills*

This association is in the sandhills and consists of hummocks and smooth side slopes.

This association makes up about 92,160 acres, or 6 percent of the county. It is 50 percent Valent soils, 35 percent Dailey soils, and 15 percent minor soils (fig. 5).

The nearly level to rolling Valent soils are on dunes in the sandhills. These soils are very deep and excessively drained. They formed in eolian sand. Typically, the surface layer is grayish brown, loose fine sand or loamy fine sand about 4 inches thick. The underlying material is pale brown fine sand to a depth of more than 60 inches.

The nearly level to strongly sloping Dailey soils are in sandhill valleys. These soils are very deep and

somewhat excessively drained. They formed in eolian sand. Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 15 inches thick. The transitional layer is pale brown, very friable fine sand about 11 inches thick. The underlying material is light yellowish brown and very pale brown fine sand to a depth of more than 60 inches.

Of minor extent in this association are Jayem, Satanta, Tuthill, and Vetal soils. Jayem, Satanta, and Tuthill soils are well drained and are on landscapes similar to those of the Dailey soils. Vetal soils are well drained and are lower on the landscape than the Dailey soils.

Farms and ranches in this association mainly support native grasses and are used as range. The less sloping areas are cultivated. Corn and alfalfa are grown in irrigated areas. Winter wheat is the main dryland crop.

Soil blowing is the principal hazard in cultivated areas or in overgrazed areas that are unprotected by a plant cover.

Cattle and cash-grain crops are marketed locally or in adjacent counties. Alfalfa is used as winter feed.

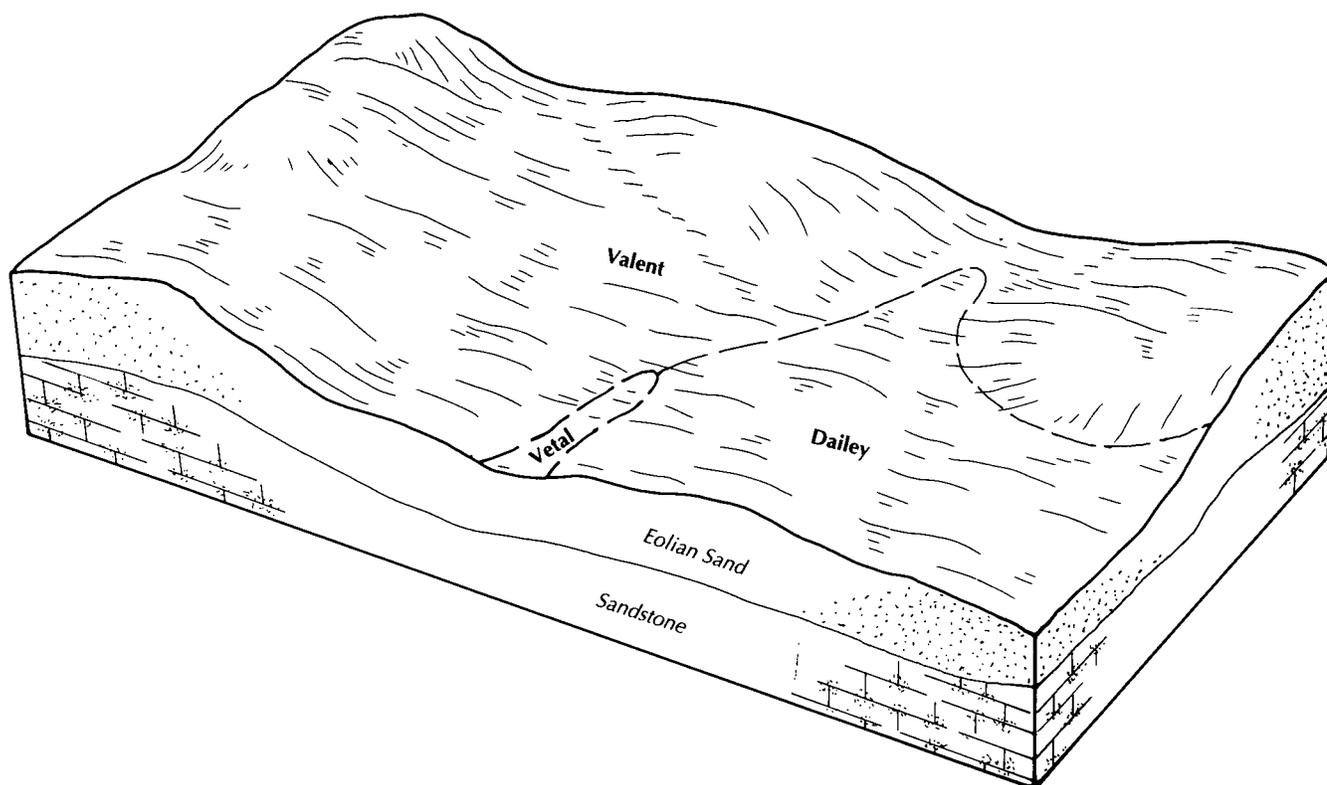


Figure 5.—Typical pattern of soils and parent material in the Valent-Dailey association.

### 13. Valent association

*Very deep, rolling and hilly, excessively drained, sandy soils; in the sandhills*

This association consists of sandhills. The rolling and hilly dunes are interspersed with gently undulating and undulating dunes. Catsteps are common on the steepest slopes.

This association makes up about 413,229 acres, or about 26 percent of the county. It is about 96 percent Valent soils and 4 percent minor soils and lakes (fig. 6).

Valent soils are very deep and excessively drained. They formed in eolian sand. Typically, the surface layer is grayish brown, loose fine sand about 4 inches thick. The underlying material is pale brown fine sand to a depth of more than 60 inches.

Of minor extent in this association are Dailey; Els, calcareous; Gannett; Hoffland; and Ipage soils and areas of small lakes. Dailey soils are on the lower side slopes and in dry sandhill valleys and have a dark

surface soil more than 10 inches thick. Els, calcareous; Gannett; Hoffland; and Ipage soils are in sandhill valleys. Els, calcareous, soils are somewhat poorly drained. Hoffland and Gannett soils are poorly drained and very poorly drained. Ipage soils are moderately well drained. Small lakes are in some of the depressions.

Nearly all of this association supports native grasses and is used for range and hayland. The rolling and hilly areas are used for range, and the nearly level and gently undulating areas are used for range and as hayland. A small acreage of the nearly level to gently sloping areas is cultivated. Corn, mixed grasses, and alfalfa are grown. Nearly all of the cultivated areas are irrigated by center-pivot or other sprinkler systems.

Ranching is well adapted to the soils in this association. Management that includes proper grazing use, timely deferment of grazing or haying, and a grazing system in which the order of grazing and rest periods are changed each year helps to maintain or improve the range condition. Erosion is the main hazard affecting cultivated areas. A system of

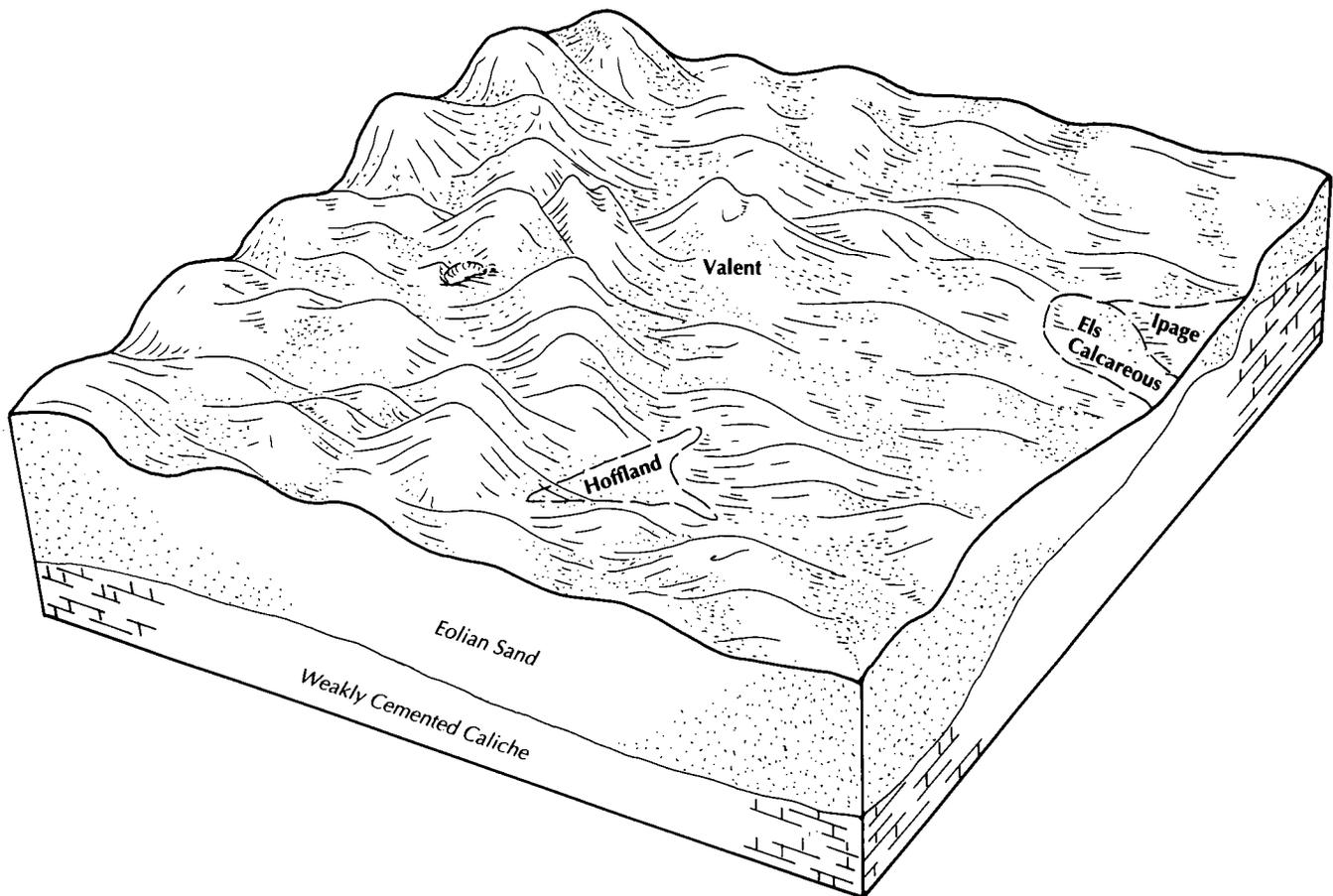


Figure 6.—Typical pattern of soils and parent material in the Valent association.

conservation tillage that leaves crop residue on the surface helps to control erosion. In irrigated areas, timely application of irrigation water and improvement of fertility are the main management concerns.

Cattle and cash-grain crops are marketed locally or in adjacent counties. Alfalfa is used as winter feed.

#### **14. Valent-Wildhorse association**

*Very deep, nearly level to hilly, excessively drained and somewhat poorly drained, sandy soils; in the sandhills*

This association consists of sandhills interspersed with valleys. The dunes range as much as 300 feet above the valley floors. The dunes on the north side of the valleys are generally very steep and have catsteps, and those on the south side of the valleys are generally rounded and smoother. The valleys are nearly level and very gently sloping. They have numerous lakes and wet areas that are surrounded by better drained soils.

This association makes up about 238,720 acres, or about 15 percent of the county. It is about 60 percent Valent soils, 20 percent Wildhorse soils, and 20 percent minor soils and lakes (fig. 7).

The nearly level to hilly Valent soils are on dunes and in sandhill valleys. They are very deep and excessively drained. They formed in eolian sand. Typically, the surface layer is grayish brown, loose fine sand about 4 inches thick. The underlying material is pale brown fine sand to a depth of more than 60 inches.

The nearly level and very gently sloping Wildhorse soils are in sandhill valleys. They are very deep and somewhat poorly drained. These soils have a high content of sodium. They formed in eolian sand and sandy alluvium. Typically, the surface layer is grayish brown, very friable, calcareous fine sand about 5 inches thick. The transitional layer is light brownish gray, calcareous fine sand about 5 inches thick. The underlying material is light brownish gray and light gray, calcareous fine sand to a depth of more than 60 inches.

Of minor extent in this association are Crowther, Dailey, Hoffland, Ipage, and Marlake soils and areas of lakes in the sandhills. Crowther and Hoffland soils are poorly drained and very poorly drained and are lower on the landscape than the Wildhorse soils. Dailey soils are somewhat excessively drained. They are higher on the landscape than the Wildhorse soils. Ipage soils are moderately well drained and are in sandhill valleys. They are slightly higher on the landscape than the Wildhorse soils. Marlake soils are very poorly drained

and are in depressions that are ponded for most of the year. They are commonly at the edges of lakes. Lakes are in the lowest parts of some of the depressions.

Nearly all of this association supports native grasses and is used for range and hayland. The rolling and hilly areas are used for range, and the larger, wet valleys are used mainly for the production of native hay. In a few cultivated areas sprinkler irrigation systems are used. Alfalfa and mixed grasses are grown.

Ranching is well adapted to the soils in this association. Management that includes proper grazing use, timely deferment of grazing or haying, and a grazing system in which the order of the grazing and rest periods are changed each year helps to maintain or improve the range condition. In cultivated areas control of soil blowing, timely application of irrigation water, and improvement of fertility are the main management concerns.

Cattle are marketed in local sale barns, sold directly to feeder operations, or hauled by truck to large terminal markets.

#### **15. Valent-Els, calcareous-Hoffland association**

*Very deep, nearly level to hilly, excessively drained, somewhat poorly drained, poorly drained, and very poorly drained, sandy and loamy soils; in the sandhills*

This association consists of sandhills and wet valleys. The hills are as much as 400 feet above the valley floors and are generally steep and very steep on the north side of the valleys. Catsteps are common on the steepest slopes. The valleys are nearly level and very gently sloping and are interspersed with lakes.

This association makes up about 117,120 acres, or about 7 percent of the county. It is about 76 percent Valent soils; 10 percent Els, calcareous, soils; 6 percent Hoffland soils; and 8 percent minor soils and lakes.

The nearly level to hilly Valent soils are on dunes in the sandhills. They are very deep and excessively drained. They formed in eolian sand. Typically, the surface layer is grayish brown, loose fine sand about 4 inches thick. The underlying material is pale brown fine sand to a depth of more than 60 inches.

The nearly level and very gently sloping Els, calcareous, soils are in sandhill valleys. They are very deep and somewhat poorly drained. They formed in eolian sand and sandy alluvium. Typically, the surface layer is gray, very friable, calcareous fine sand about 7 inches thick. The transitional layer is grayish brown,

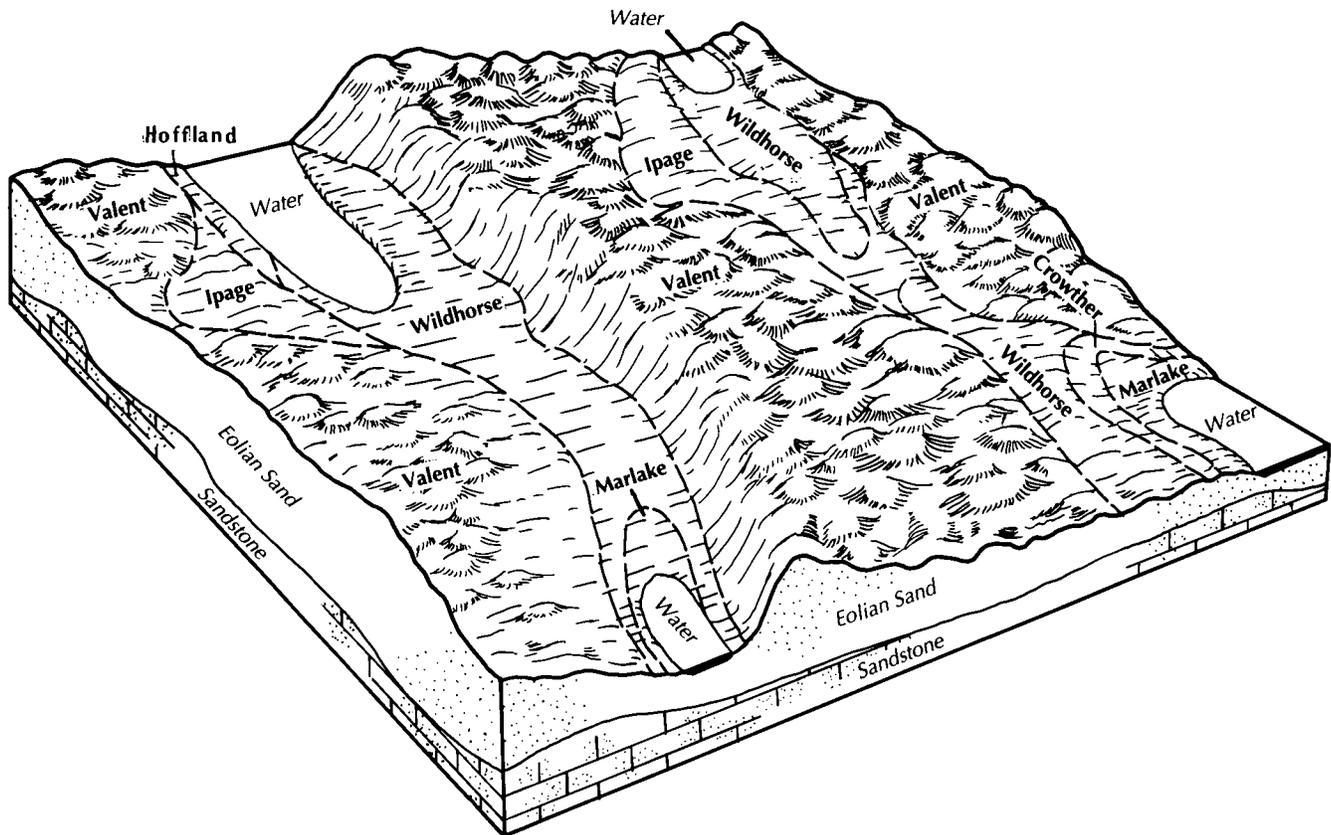


Figure 7.—Typical pattern of soils and parent material in the Valent-Wildhorse association.

very friable fine sand about 6 inches thick. The underlying material is pale brown fine sand to a depth of more than 60 inches.

The nearly level Hoffland soils are in sandhill valleys. They are very deep and are poorly drained and very poorly drained. They formed in sandy alluvium. Typically, the surface layer is gray, very friable, calcareous fine sandy loam about 4 inches thick. The subsurface layer is friable, calcareous fine sandy loam about 7 inches thick. It is gray in the upper part and light brownish gray in the lower part. The underlying material to a depth of 60 inches or more is fine sand. The upper part is light brownish gray and is mottled, and the lower part is light gray and is stratified with fine sandy loam.

Of minor extent in this association are Elsmere, Ipage, Marlake, Tryon, and Wildhorse soils and areas of lakes in the sandhills. Elsmere soils are somewhat poorly drained and have a dark surface soil more than 10 inches thick. They are on landscapes similar to those of the Els, calcareous, soils. Tryon soils are poorly drained and very poorly drained and are lower on the landscape than the Els, calcareous, soils. Ipage

soils are moderately well drained. They are slightly higher on the landscape than the Els, calcareous, soils and are lower on the landscape than the Valent soils. Marlake soils are very poorly drained and are in depressions that are ponded for most of the year. Wildhorse soils have a high content of sodium and are on landscapes similar to those of the Els, calcareous, soils. Lakes are in some of the depressions.

Nearly all of this association supports native grasses and is used for range and hayland. The rolling and hilly areas are used for range, and the wet valleys are used mainly for the production of native hay. In a few small cultivated areas sprinkler irrigation systems are used. Alfalfa is the principal crop.

Ranching is well adapted to the soils in this association. Maintaining desirable grasses through a grazing system in which the order of the grazing and rest periods are changed every year and establishing adequate and proper placement of water facilities are the main management concerns. In cultivated areas timely application of irrigation water, control of soil blowing, and improvement of fertility are the main management concerns.

Cattle are marketed in local sale barns, sold directly to feeder operations, or hauled by truck to large terminal markets.

## 16. Valentine-Tryon-lpage association

*Very deep, nearly level to hilly, excessively drained, moderately well drained, poorly drained, and very poorly drained, sandy and loamy soils; in the sandhills*

This association consists of hummocky sandhills with intervening wet valleys. Slopes range from 0 to 60 percent. The soils in this association formed in eolian sand and alluvium.

This association makes up 76,160 acres, or about 5 percent of the county. It is about 55 percent Valentine soils, 17 percent Tryon soils, 11 percent lpage soils, and 17 percent minor soils.

The gently sloping to hilly Valentine soils are on dunes in the sandhills. They are very deep and excessively drained. They formed in eolian sand. Typically, the surface layer is pale brown, loose fine sand about 6 inches thick. The underlying material is very pale brown fine sand to a depth of more than 60 inches.

The nearly level Tryon soils are in sandhill valleys. They are very deep and are poorly drained and very poorly drained. They formed in eolian sand and sandy alluvium. Typically, the surface layer is very dark grayish brown, very friable fine sandy loam about 6 inches thick. The underlying material extends to a depth of more than 60 inches. The upper part is light brownish gray fine sand, the middle part is mottled, light brownish gray loamy fine sand, and the lower part is light gray fine sand.

The nearly level and very gently sloping lpage soils are in sandhill valleys. They are very deep and moderately well drained. They formed in eolian sand. Typically, the surface layer is dark grayish brown, loose fine sand about 5 inches thick. The transitional layer is grayish brown, loose fine sand about 6 inches thick. The underlying material to a depth of more than 60 inches is light brownish gray in the upper part and mottled pale brown in the lower part.

Of minor extent in this association are Els, calcareous; Elsmere; Gannett; and Marlake soils. Els, calcareous, and Elsmere soils are somewhat poorly drained and are in sandhill valleys. Gannett soils are poorly drained and very poorly drained and have a loamy surface layer and subsurface layer. They are in sandhill valleys. Marlake soils are in depressions in sandhill valleys and are ponded for most of the year.

Nearly all of this association supports native grasses used for range and hayland. The subirrigated valleys are used as hayland. Most of this association is unsuited to cultivated crops because of the slope and the wetness of the valleys. Ranches in this association are predominantly cow-calf livestock enterprises. Wells provide good-quality water for livestock.

Overgrazing can reduce the protective cover and result in deterioration of the native plants. Management that includes proper grazing use, timely deferment of grazing and haying, and restricted use during very wet periods helps to maintain or improve the range condition. The seasonal high water table benefits grasses during dry periods but hinders haying during wet periods. Soil blowing can be controlled by an adequate plant cover.



## Detailed Soil Map Units

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

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

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

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the 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, Alliance loam, 1 to 3 percent slopes, is a phase of the Alliance series.

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

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. Oglala-Canyon complex, 11 to 30 percent slopes, is an example.

A *soil association* is made up of two or more

geographically associated soils that are shown as one unit on the maps. Because of present or anticipated soil uses in the survey area, it was not considered practical or necessary to map the soils separately. The pattern and relative proportion of the soils are somewhat similar. Tassel-Ponderosa-Rock outcrop association, 9 to 70 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. Badland 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.

Some soil boundaries and soil names in this survey do not fully match those in the surveys of adjoining counties that were published at an earlier date. Differences are the result of changes and refinements in series concepts, variations in slope groupings, and application of the latest classification system.

### Soil Descriptions

**Ac—Alliance loam, 0 to 1 percent slopes.** This deep, nearly level, well drained soil is on uplands. It formed in loess and the underlying calcareous sandstone. Areas range from 5 to 100 acres in size.

Typically, the surface layer is dark grayish brown, very friable loam about 6 inches thick. The subsurface

layer is grayish brown, very friable loam about 4 inches thick. The subsoil is about 13 inches thick. The upper part is grayish brown, friable silty clay loam. The middle part is light brownish gray, friable silty clay loam, and the lower part is light gray, friable loam. The underlying material is white, very friable loam to a depth of 53 inches. Below this to a depth of 60 inches or more is white, calcareous sandstone. In some places calcareous sandstone is at a depth of 20 to 40 inches. In other places the surface layer is silt loam.

Included with this soil in mapping are small areas of Duroc soils, which have a dark surface soil more than 20 inches thick and are in slightly concave areas. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Alliance soil. Available water capacity is high. The organic matter content is moderate. Runoff is slow. The water intake rate is moderately low.

Nearly all of the acreage of this soil is cultivated. About half of the acreage is used for dryland farming, and the rest is used as irrigated cropland. A few areas are used for range.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Soil blowing is a slight hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to conserve soil moisture and control soil blowing. Cover crops also help to control soil blowing. Returning crop residue to the soil helps to maintain the organic matter content and fertility and improves the water intake rate.

If irrigated, this soil is suited to corn; dry, edible beans; sugar beets; small grains; alfalfa; and introduced grasses. Water can be applied by a sprinkler or a gravity system. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue and green manure crops into the soil helps to maintain the organic matter content and fertility. All irrigation systems need to be designed so that the water application rate does not exceed the moderately low intake rate of this soil. A tailwater recovery system can be used to conserve water.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with other crops. Such cool-season grasses as

pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler and gravity systems. Weeds can be controlled if the appropriate herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil blowing. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plant communities.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate rainfall is the principal hazard affecting seedlings and young trees. Seedlings can survive and grow if competing vegetation is controlled or removed by cultivation between the tree rows or by careful use of the appropriate kind of herbicide. Planting an annual cover crop between the tree rows helps to control soil blowing. Irrigation can provide supplemental moisture during periods of low rainfall.

The use of this soil for septic tank absorption fields is limited by depth to bedrock. This limitation can be overcome by mounding the site with several feet of suitable fill material to improve the filtering capacity of the soil. The moderate permeability of this soil is a limitation affecting septic tank absorption fields, but increasing the size of the absorption field can generally overcome this limitation. This soil is generally suited to sites for dwellings. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

The land capability units are Ilc-1, dryland, and I-4, irrigated; Silty range site; and windbreak suitability group 3.

**AcB—Alliance loam, 1 to 3 percent slopes.** This deep, very gently sloping, well drained soil is on uplands. It formed in loess and the underlying calcareous sandstone. Areas range from 5 to 750 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 8 inches thick. The subsoil is about 15 inches thick. The upper part is grayish brown, firm silty clay loam; the middle part is pale brown, firm silty clay loam; and the lower part is pale brown, friable loam. The underlying material is light gray, calcareous very fine sandy loam to a depth of 49 inches. Below this to a depth of 60 inches or more is white, calcareous sandstone. In some places the bedrock is at a depth of more than 60 inches. In other places the surface layer is silt loam. In some areas the subsoil is sandy clay loam.

Included with this soil in mapping are small areas of Duroc and Rosebud soils. Duroc soils have a dark surface soil more than 20 inches thick and are in slightly concave areas on the landscape that are lower than the Alliance soil. Rosebud soils are 20 to 40 inches deep over calcareous sandstone and are on convex knolls that are higher on the landscape than the Alliance soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Alliance soil. Available water capacity is high. The organic matter content is moderate. Runoff is slow. The water intake rate is moderately low.

Most of the acreage of this soil is cultivated (fig. 8). About half of the acreage is used for dryland farming, and the rest is used as irrigated cropland. A few areas are used as rangeland.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Soil blowing and water erosion are slight hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to conserve soil moisture and control soil blowing. Cover crops also help to control erosion. Returning crop residue to the soil helps to maintain the organic matter content and fertility and improves the water intake rate.

If irrigated, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. Water can be applied by a sprinkler or a gravity system. Land leveling is generally needed if a gravity system is used so that water movement and intake rate are uniform. Soil blowing and water erosion are slight hazards. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue

on the surface helps to control soil blowing and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue into the soil helps to maintain the organic matter content and fertility. All irrigation systems need to be designed so that the water application rate does not exceed the moderately low intake rate of this soil. A tailwater recovery system can be used to conserve water.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with other crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler and gravity systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil blowing. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferrals from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plant communities.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate rainfall and soil erosion are the principal hazards affecting seedlings and young trees. Seedlings can survive and grow if competing vegetation is controlled or removed by cultivation between the tree rows or by careful use of the appropriate kind of herbicide. Planting an annual cover crop between the tree rows helps to control soil blowing. Irrigation can provide supplemental moisture during periods of low rainfall.

The use of this soil for septic tank absorption fields is limited by depth to bedrock. This limitation can be overcome by mounding the site with several feet of suitable fill material to improve the filtering capacity of the soil. The moderate permeability of this soil is a



Figure 8.—Most areas of Alliance loam, 1 to 3 percent slopes, are used as cropland.

limitation affecting septic tank absorption fields, but increasing the size of the absorption field can generally overcome this limitation. On sites for sewage lagoons, some grading is needed to modify the slope and to shape the lagoon. This soil is generally suited to sites for dwellings. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

The land capability units are 11e-1, dryland, and 11e-4, irrigated; Silty range site; and windbreak suitability group 3.

**AcC—Alliance loam, 3 to 6 percent slopes.** This deep, gently sloping, well drained soil is on uplands. It formed in loess and the underlying calcareous sandstone. Areas range from 5 to 500 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 9 inches thick. The subsoil is about 14 inches thick. The upper part is grayish brown, firm

silty clay loam, and the lower part is pale brown, friable, calcareous silt loam. The underlying material is light gray and calcareous. It is loam in the upper part and very fine sandy loam in the lower part. White, calcareous, fine grained sandstone is below a depth of about 56 inches and extends to a depth of 60 inches or more. In cultivated areas 5 to 20 percent of this soil is eroded. In these areas erosion has removed all or most of the original surface soil, and tillage has mixed the remaining surface layer with the subsurface soil. In most places the surface layer is light in color and calcareous. In other places the surface layer is silty clay loam, silt loam, or fine sandy loam. In some places sandstone is at a depth of more than 60 inches.

Included with this soil in mapping are small areas of Canyon, Duroc, and Rosebud soils. Canyon soils have calcareous sandstone at a depth of 10 to 20 inches. Duroc soils have a dark surface soil more than 20 inches thick and are in concave areas that are lower on the landscape than the Alliance soil. Rosebud soils

are 20 to 40 inches deep over calcareous sandstone and generally are slightly higher on the landscape than the Alliance soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Alliance soil. Available water capacity is high. The organic matter content is moderate. Runoff is medium. The water intake rate is moderately low.

Most of the acreage of this soil is cultivated. About half of the acreage is used for dryland farming, and the rest is used as irrigated cropland. A few areas are used as rangeland.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Water erosion and soil blowing are the principal hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to conserve soil moisture and control serious soil blowing and water erosion. Cover crops also help to control erosion. Returning crop residue to the soil helps to maintain the organic matter content and tilth and improves the water intake rate.

If irrigated by a sprinkler system, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. A sprinkler system is best suited to this soil. Gravity systems need to be leveled to a proper grade so that water movement and intake are uniform. Soil erosion is the principal hazard. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control water erosion and soil blowing and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue into the soil helps to maintain the organic matter content and fertility. The efficient use of irrigation water is a management concern because the application of excessive amounts of water can result in water erosion on these slopes. All irrigation systems need to be designed so that the water application rate does not exceed the moderately low intake rate of this soil. A tailwater recovery system can be used to conserve water.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with other crops. Such cool-season grasses as pubescent wheatgrass or intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be

seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. This soil is subject to water erosion. Continuous heavy grazing causes poor plant vigor and reduced forage production. Continuous heavy grazing and improper haying also reduce the amount of protective cover, resulting in soil blowing and the formation of small gullies and rills after heavy rains. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil blowing and water erosion. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plant communities. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate rainfall and soil blowing are the principal hazards affecting seedlings and young trees. Seedlings can survive and grow if competing vegetation is controlled or removed by cultivation between the tree rows or by careful use of the appropriate kind of herbicide. Planting an annual cover crop between the tree rows helps to control soil blowing. Irrigation can provide supplemental moisture during periods of low rainfall.

The use of this soil for septic tank absorption fields is limited by depth to bedrock. This limitation can be overcome by mounding the site with several feet of suitable fill material to improve the filtering capacity of the soil. The moderate permeability of this soil is a limitation affecting septic tank absorption fields, but increasing the size of the absorption field can generally overcome this limitation. Buildings and dwellings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

The land capability units are IIIe-1, dryland, and IIIe-4, irrigated; Silty range site; and windbreak suitability group 3.

**An—Almeria loamy fine sand, channeled, 0 to 2 percent slopes.** This very deep, very gently sloping, very poorly drained soil is on channeled bottom land generally adjacent and parallel to the Niobrara River (fig. 9). The soil formed in sandy alluvium. It is frequently flooded for brief periods and is occasionally ponded by water from the seasonal high water table. Areas range from 5 to 500 acres in size.

Typically, the surface layer is grayish brown, very friable, calcareous loamy fine sand about 8 inches thick. It has dark yellowish brown mottles. The underlying material is light gray, calcareous sand stratified with loamy very fine sand to a depth of more than 60 inches. The upper part has yellowish brown mottles. In some places the surface layer is fine sandy loam or fine sand. In a few areas the underlying material has thin strata of gravelly coarse sand.

Included with these soils in mapping are small areas of Bolent and Calamus soils, Fluvaquents, and areas of water. Bolent and Calamus soils are better drained than the Almeria soil and are slightly higher on the landscape. Areas of Fluvaquents are lower on the landscape than the Almeria soil and generally have water above the surface most of the year. Included areas make up 10 to 15 percent of the unit.

Permeability is rapid in the Almeria soil. Available water capacity is low. The organic matter content is moderately low. Runoff is very slow. The seasonal high water table ranges from 0.5 foot above the surface during wet years to a depth of 1.0 foot during dry years.

Most of the acreage of this soil is used for range. The rest is covered by trees and shrubs. The dominant vegetation is American licorice, cottonwood, and willow. The soil provides good habitat for wildlife.

This soil is not suited to farming because of the wetness and the hazard of frequent flooding.

If this soil is used as range or hayland, the climax vegetation is dominantly prairie cordgrass, bluejoint reedgrass, northern reedgrass, and sedges. These species make up 65 percent or more of the total annual forage. Bluegrass, slender wheatgrass, green muhly, and forbs make up the rest. If subject to continuous heavy grazing or improperly harvested for hay, prairie cordgrass, bluejoint reedgrass, and northern reedgrass decrease in abundance and are replaced by slender wheatgrass, bluegrass, green muhly, sedges, rushes, and forbs. If overgrazing or improper haying continues for many years, bluegrass,

foxtail barley, sedges, rushes, and forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 2.0 animal unit months per acre. This soil produces a high quantity of low-quality forage. A planned grazing system that includes proper grazing use, timely deferments from grazing and haying, and restricted use during very wet periods helps to maintain or improve the range condition. During wet periods, grazing and operating heavy machinery can cause surface compaction and the formation of mounds and ruts, which make grazing or harvesting hay difficult.

If this soil is used as hayland, mowing should be regulated so that the grasses remain healthy and vigorous. In wet years, some areas of hay cannot be harvested. After the ground is frozen, livestock can graze without damaging the meadows. They should be removed in the spring before the ground thaws.

This soil is not suited to the trees and shrubs planted in windbreaks because of the wetness caused by the high water table and the hazard of frequent flooding. A few marginal areas may be suitable for the trees and shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used.

These soils are not suited to septic tank absorption fields, dwellings, or buildings because of the flooding and the seasonal high water table. A suitable alternative site should be selected. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving if the shoring takes place during dry periods. Constructing roads on suitable, well compacted fill material, providing adequate side ditches, and installing culverts help protect roads from the damage caused by floodwater and the wetness caused by the seasonal high water table. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

The land capability unit is VIw-7, dryland; Wetland range site; and windbreak suitability group 10.

**Bc—Bankard loamy fine sand, channeled, 0 to 2 percent slopes.** This very deep, somewhat excessively drained soil is on bottom land. It is subject to frequent flooding. The soil formed in sandy alluvium. Areas range from 5 to 75 acres in size.

Typically, the surface layer is grayish brown, very friable loamy fine sand about 7 inches thick. The underlying material is calcareous and extends to a depth of more than 60 inches. The upper part is light brownish gray, stratified fine sand, and the lower part



**Figure 9.—A typical area of Almeria loamy fine sand, channeled, 0 to 2 percent slopes, adjacent to the Niobrara River. This soil is frequently flooded.**

is light gray, stratified loamy very fine sand. In some places the surface layer is loam, fine sandy loam, or fine sand.

Included with this soil in mapping are small areas of Munjor soils and areas of rock outcrop. Also included are areas along the drainageways that have very steep side slopes. Munjor soils are well drained and have less sand and more clay in the profile than the Bankard soil. These soils are on similar landscapes. The areas of rock outcrop are higher on the landscape than the Bankard soil. They are on breaks along the channel. Included areas make up 10 to 20 percent of the unit.

Permeability is rapid in the Bankard soil, and available water capacity is low. The organic matter content is moderately low. Runoff is slow. The water intake rate is very high.

Most areas of this soil are used as range or hayland. A few areas are covered by trees and shrubs. The dominant vegetation is cottonwood, green ash, and buckbrush.

This soil is not suited to cropland because of the hazard of frequent flooding.

If this soil is used as range or hayland, the climax vegetation is dominantly sand bluestem, prairie sandreed, needleandthread, and switchgrass. These species make up 45 percent or more of the total annual forage. Blue grama, prairie junegrass, bluegrass, indiagrass, sedges, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, indiagrass, little bluestem, and switchgrass decrease in abundance and are replaced by prairie sandreed, needleandthread, sand dropseed, blue grama, sedges, and forbs. If overgrazing continues for many years, blue grama, sand dropseed, needleandthread, Scribner panicum, sedges, and forbs dominate the site. Under these conditions, the native plants lose vigor and are unable to stabilize the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing

use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, mowing should be regulated so that the grasses remain healthy and vigorous. The forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range.

This soil generally is not suited to the trees and shrubs planted in windbreaks. A few areas can be used for the trees and shrubs that enhance recreational areas or wildlife habitat if they are planted by hand or if other special management is used.

This soil is not suited to use as sites for sanitary facilities or buildings because of the frequent flooding. An alternative site should be selected. The sides of shallow excavations can cave in unless they are shored. If areas of this soil are used for roads, bridges or culverts are needed. Constructing roads on suitable, well compacted material above the flood level and providing adequate side ditches help to prevent the damage caused by floodwater.

The land capability unit is Vlw-5, dryland; Sandy Lowland range site; and windbreak suitability group 10.

#### **Bd—Beckton silt loam, 0 to 2 percent slopes.**

This very deep, nearly level, moderately well drained soil is on alluvial fans and low stream terraces. This soil formed in loamy alluvium. It is subject to rare flooding. Areas range from 10 to 1,200 acres in size.

Typically, the surface layer is dark grayish brown, very friable silt loam about 5 inches thick. The subsurface layer is light gray, very friable silt loam about 3 inches thick. The subsoil is about 27 inches thick. It is grayish brown, firm silty clay loam in the upper part and brown, firm, calcareous silt loam in the lower part. The underlying material is light gray, calcareous silt loam to a depth of 60 inches or more. This soil has a high content of sodium. In some places the surface layer is fine sandy loam or loamy fine sand. In some areas the dark surface layer is less than 7 inches thick. In other areas the subsoil is sandy clay loam or loam.

Included with this soil are small areas of Lute and McCook soils. Lute soils are somewhat poorly drained and are lower on the landscape than the Beckton soil. McCook soils are not sodium-affected and are well drained. These soils are slightly higher on the

landscape than the Beckton soil. Included soils make up 5 to 15 percent of the unit.

Permeability is slow in the Beckton soil. Available water capacity is moderate. Runoff is slow, and water may stand in microdepressions on the surface for short periods. Organic matter content is moderately low. This soil contains sodium and other salts that are detrimental to crops. The water intake rate is moderate. The seasonal high water table ranges from a depth of about 4 feet during wet years to about 6 feet during dry years.

Most of the acreage of this soil supports native grasses and is used as rangeland or hayland. The rest is used for irrigated crops.

If dryland farmed, this soil is poorly suited to small grains, alfalfa, and introduced grasses. The sodium in the subsoil is toxic to some plants. This soil is flooded for very brief periods, and damage to crops is seldom severe. Soil blowing is also a serious hazard on unprotected surfaces. A system of conservation tillage, such as stubble mulching and ecofallow, helps to control soil blowing and conserve soil moisture. This soil is droughty in summer. The first cutting of alfalfa is the most suitable crop because it grows and matures in the spring when the amount of rainfall is plentiful. Stripcropping helps to control soil blowing. Summer fallowing conserves moisture for use during the following growing season.

If irrigated by a sprinkler system, this soil is poorly suited to small grains, alfalfa, and introduced grasses. The sodic condition of the soil limits crop production because sodium is toxic to some plants. This soil is flooded for very brief periods, and damage to crops is seldom severe. A system of conservation tillage, such as no-till or ecofallow, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture.

If this soil is used as range or hayland, the climax vegetation is dominated by alkali sacaton, inland saltgrass, blue grama, and western wheatgrass. These species make up 60 percent or more of the total annual forage. Buffalograss, bluegrass, slender wheatgrass, sedges, and forbs make up the rest. If subject to continuous heavy grazing, alkali sacaton, western wheatgrass, and slender wheatgrass decrease in abundance and are replaced by inland saltgrass, blue grama, buffalograss, bluegrass, and sedges.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain and improve the range condition. Properly located fences and livestock watering and

salting facilities can result in a more uniform distribution of grazing. The alkalinity of the soil varies, which results in irregular patterns of short and tall grasses. Short grasses are dominant in areas where the alkalinity is high.

If this soil is used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy.

This soil is poorly suited to the trees and shrubs planted in windbreaks because of the high content of sodium. The sodic condition of the soil limits the species that can be grown. Only species that are tolerant of a high content of sodium should be selected. The weeds and undesirable grasses can be controlled by cultivation between the tree rows with conventional equipment. Areas in the rows that are close to the trees can be hoed by hand or rototilled, or an appropriate kind of herbicide can be used to control the competing vegetation. Irrigation can provide supplemental moisture during periods of low rainfall.

Constructing septic tank absorption fields on fill material raises the fields a sufficient distance above the seasonal high water table. The slow permeability of the subsoil is a limitation affecting septic tank absorption fields, but increasing the size of the absorption field can generally overcome this limitation. Strengthening the foundations of dwellings and buildings and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling, and constructing roads on raised, well compacted fill material helps to prevent the damage caused by floodwater. Mixing the base material for roads and streets with additives, such as hydrated lime, can help to prevent shrinking and swelling. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. Constructing roads on suitable, well compacted fill material above the flood level, providing adequate side ditches, and installing culverts help to prevent the damage to roads caused by floodwater.

The land capability units are IVs-1, dryland, and IVs-5, irrigated; Saline Lowland range site; and windbreak suitability group 9S.

**Bf—Bolent loamy fine sand, 0 to 2 percent slopes.** This very deep, nearly level, somewhat poorly drained soil is on bottom land along the Niobrara River and other major drainageways. The soil formed in sandy alluvium. It is occasionally flooded for brief periods. Areas of this soil are commonly long and narrow and range from 15 to 400 acres in size.

Typically, the surface layer is light brownish gray, very friable, calcareous loamy fine sand about 7 inches thick. The underlying material extends to a depth of 60 inches or more. The upper part is light gray, calcareous fine sand stratified with grayish brown loamy fine sand; the middle part is stratified white and light gray, mottled, calcareous fine sand; the next part is white fine sand stratified with light gray loamy very fine sand; and the lower part is white fine sand. In some places the surface layer is very fine sandy loam, fine sandy loam, or fine sand.

Included with this soil in mapping are small areas of Almeria, Calamus, and Las Animas soils. Almeria soils are lower on the landscape than the Bolent soil and are very poorly drained. Calamus soils are higher on the landscape than the Bolent soil and are moderately well drained. Las Animas soils are less sandy in the profile than the Bolent soil and are on similar landscapes. Included soils make up 10 to 15 percent of the unit.

Permeability is rapid in the Bolent soil, and available water capacity is low. The organic matter content is low. Runoff is very slow. The water intake rate is very high. This soil has a seasonal high water table that ranges from a depth of 1.5 feet during wet years to 3.0 feet during dry years.

Most areas of this soil are used as range or hayland. A few areas along the Niobrara River are covered by trees and shrubs. The dominant vegetation is cottonwood, willow, and buckbrush.

If dryland farmed, this soil is poorly suited to the crops commonly grown in the county. Flooding and the wetness caused by the seasonal high water table are hazards. The low available water capacity is a severe limitation during dry periods.

If irrigated by a sprinkler system, this soil is poorly suited to corn, small grains, alfalfa, and introduced grasses. This soil is not suited to a gravity system because of the very high water intake rate and rapid permeability. This soil is flooded for brief periods, but the damage to crops caused by flooding is seldom severe. The main limitation is the wetness caused by the high water table. Soil blowing is also a hazard on unprotected surfaces. This soil dries out slowly in the spring, and tillage and planting are delayed because of the wetness. A system of conservation tillage, such as no-till, keeps crop residue on the surface and helps to control soil blowing and conserve moisture. Cover crops also help to control erosion. Returning crop residue to the soil helps improve the organic matter content and fertility. Supplemental applications of nitrogen and phosphorus are needed for maximum crop production. The efficient use of irrigation water is a management concern because excessive amounts

of water leach plant nutrients. This soil needs frequent applications of irrigation water because of the low available water capacity.

If this soil is used as range or hayland, the climax vegetation is dominantly big bluestem, little bluestem, indiangrass, switchgrass, and sedges. These species make up 75 percent or more of the total annual forage. Prairie cordgrass, bluegrass, and forbs dominate the rest. If subject to continuous heavy grazing or improperly harvested for hay, big bluestem, little bluestem, indiangrass, switchgrass, and prairie cordgrass decrease in abundance and are replaced by western wheatgrass, bluegrass, slender wheatgrass, green muhly, sedges, and rushes. If overgrazing or improper haying continues for many years, bluegrass, sedges, rushes, and forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 1.6 animal unit months per acre. A planned grazing system that includes proper grazing use, timely deferments from grazing and haying, and restricted use during wet periods helps to maintain or improve the range condition. Areas of this soil are generally the first to be overgrazed in a pasture that includes the better drained, sandy soils. Properly located fences and livestock watering and salting facilities result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. The hay is of best quality when the grasses are cut early. After the ground is frozen, livestock can graze without damaging the meadows. They should be removed in the spring before the ground thaws.

This soil is suited to the trees and shrubs planted in windbreaks. The species selected for planting should be those that withstand the occasional wetness. The main limitation affecting the establishment of windbreaks is the wetness caused by the high water table. Tilling and planting seedlings should be delayed until after the soil has begun to dry. The weeds and undesirable grasses can be controlled by cultivation between the tree rows with conventional equipment and by the use of the appropriate kind of herbicide in the rows. Care is also needed during the establishment of windbreaks to prevent soil blowing during dry periods.

The hazard of occasional flooding needs to be considered if this soil is used for sanitary facilities and building sites. Constructing septic tank absorption fields on fill material raises the fields a sufficient distance above the seasonal high water table. This soil readily absorbs but does not adequately filter the

effluent from septic tank absorption fields. The poor filtering capacity can result in pollution of the ground water. Constructing dwellings and buildings on raised, well compacted fill material helps to prevent the damage caused by floodwater and helps to overcome the wetness caused by the high water table. Constructing roads on suitable, well compacted fill material above the flood level, providing adequate side ditches, and installing culverts help protect roads from the damage caused by floodwater and the wetness caused by the seasonal high water table. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving if the shoring takes place during dry periods.

The land capability units are IVw-5, dryland, and IVw-11, irrigated; Subirrigated range site; and windbreak suitability group 2S.

**Bh—Bridget very fine sandy loam, 0 to 1 percent slopes.** This very deep, nearly level, well drained soil is on foot slopes, stream terraces, and alluvial fans. The soil formed in loamy colluvial and alluvial sediments. Areas range from 5 to 500 acres in size.

Typically, the surface layer is grayish brown, very friable very fine sandy loam about 8 inches thick. The subsurface layer is dark grayish brown, very friable very fine sandy loam about 7 inches thick. The transitional layer is pale brown, very friable, calcareous very fine sandy loam about 6 inches thick. The underlying material is calcareous very fine sandy loam to a depth of more than 60 inches. The upper part is pale brown, and the lower part is light brownish gray. In some places the surface layer is loam. In other places carbonates are below a depth of 15 inches.

Included with these soils in mapping are small areas of Ponderosa and Thirtynine soils. Ponderosa soils contain more sand than the Bridget soil and are higher on the landscape. Thirtynine soils have more clay than the Bridget soil and are higher on the landscape. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Bridget soil, and available water capacity is high. Organic matter content is moderate. Runoff is very slow. The water intake rate is moderate.

Most of the acreage of this soil is used for farming. A few small areas are irrigated. The rest is used as rangeland.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can

be successfully grown. Soil blowing is a hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to conserve soil moisture and control soil blowing. Cover crops also help to control soil blowing. Returning crop residue to the soil helps improve the organic matter content and the water intake rate.

If irrigated, this soil is suited to corn, field beans, small grains, alfalfa, and introduced grasses. Water can be applied by sprinkler or gravity systems. For gravity irrigation systems, some land leveling generally is needed so that water movement and intake rate are uniform. Soil blowing is a hazard. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue and green manure crops into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water leach plant nutrients below the root zone.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with other crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler or gravity systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil blowing. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. As a result, soil blowing is excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

If this soil is used as range, the natural plant community is mostly short and mid grasses and some tall grasses. Blue grama, needleandthread, sideoats

grama, and western wheatgrass are dominant. If overgrazed, the mid and tall grasses lose vigor and blue grama, buffalograss, western wheatgrass, pricklypear, and other annual and perennial weeds become the dominant species.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate rainfall and soil blowing are the principal hazards affecting seedlings and young trees. Seedlings can survive and grow if competing vegetation is controlled or removed by cultivation between the tree rows or by careful use of the appropriate kind of herbicide. Planting an annual cover crop between the tree rows helps to control soil blowing. Irrigation can provide supplemental moisture during periods of low rainfall.

This soil is generally suited to use as building sites. The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

The land capability units are Ilc-1, dryland, and Ile-6, irrigated; Silty range site; and windbreak suitability group 3.

**BhB—Bridget very fine sandy loam, 1 to 3 percent slopes.** This very deep, very gently sloping, well drained soil is on foot slopes, stream terraces, and alluvial fans. The soil formed in loamy colluvial and alluvial sediments. Areas range from 5 to more than 500 acres in size.

Typically, the surface layer is dark grayish brown, very friable very fine sandy loam about 7 inches thick. The subsurface layer is about 7 inches thick. It is similar to the surface layer in color and texture. The transitional layer is pale brown, very friable, calcareous very fine sandy loam about 5 inches thick. The underlying material to a depth of more than 60 inches is pale brown, very friable, calcareous very fine sandy loam. In some places the surface layer is loam. In other places carbonates are below a depth of 15 inches.

Included with this soil in mapping are small areas of Ponderosa and Thirtynine soils. Ponderosa soils contain more sand than the Bridget soil and are higher on the landscape. Thirtynine soils have more clay than the Bridget soil and are higher on the landscape. Included soils make up 5 to 15 percent of the map unit.

Permeability is moderate in the Bridget soil. Available water capacity is high. Organic matter

content is moderate. Runoff is slow. The water intake rate is moderate.

Most of the acreage of this soil is used for dryland farming. A few small areas are irrigated. The rest is mainly used as rangeland.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Water erosion and soil blowing are the principal hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to conserve soil moisture and control water erosion and soil blowing. Cover crops also help to control erosion. Returning crop residue to the soil helps improve the organic matter content and the water intake rate.

If irrigated, this soil is suited to corn, field beans, small grains, alfalfa, and introduced grasses. Water can be applied by sprinkler or gravity systems. For gravity irrigation systems, some land leveling is needed so that water movement and intake are uniform. Water erosion and soil blowing are the principal hazards. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue and green manure crops into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water leach plant nutrients below the root zone.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with other crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. This soil is subject to water erosion. Continuous heavy grazing and improper haying also reduce the amount of protective cover and can result in soil blowing and the formation of small gullies and rills after heavy rains. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler

systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil blowing and water erosion. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate rainfall and erosion are the principal hazards affecting seedlings and young trees. Seedlings can survive and grow if competing vegetation is controlled or removed by cultivation between the tree rows or by careful use of the appropriate kind of herbicide. Planting an annual cover crop between the tree rows helps to control water erosion and soil blowing. Irrigation can provide supplemental moisture during periods of low rainfall.

This soil is generally suited to use as building sites. The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

The land capability units are 11e-3, dryland, and 11e-6, irrigated; Silty range site; and windbreak suitability group 3.

**Bm—Bridget loam, 0 to 1 percent slopes.** This very deep, nearly level, well drained soil is on foot slopes, stream terraces, and alluvial fans. The soil formed in loamy alluvial sediment. Areas range from 20 to 1,000 acres in size.

Typically, the surface layer is grayish brown, very friable loam about 6 inches thick. The subsurface layer is about 3 inches thick. It is similar to the surface layer in color and texture. The transitional layer is light brownish gray, very friable, calcareous loam about 6 inches thick. The underlying material to a depth of more than 60 inches is light gray, calcareous loam. In some places the surface layer is silt loam or very fine sandy loam. In other places carbonates are below a depth of 15 inches.

Included with this soil in mapping are small areas of Duroc, McCook, and Thirtynine soils. Duroc soils have a dark surface soil more than 20 inches thick and are in swales. They are lower on the landscape than the

Bridget soil. McCook soils are stratified and are lower on the landscape than the Bridget soil. Thirty-nine soils have more clay than the Bridget soil and are higher on the landscape. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Bridget soil, and available water capacity is high. The organic matter content is moderate. Runoff is very slow. The water intake rate is moderate.

Most of the acreage of this soil is cultivated. Nearly all of the cultivated areas are used for dryland farming. A few small areas are irrigated. The rest are used as rangeland.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Soil blowing is a slight hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to conserve soil moisture and control soil blowing. Cover crops also help to control erosion. Returning crop residue to the soil helps improve the organic matter content and the water intake rate.

If irrigated, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. Water can be applied by sprinkler or gravity systems. For gravity irrigation systems, some land leveling generally is needed. Soil blowing is a slight hazard. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue and green manure crops into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water leach plant nutrients below the root zone.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with other crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing,

proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil blowing. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help keep the native plants in good condition.

If this soil is used as range, the natural plant community is dominated by blue grama, needleandthread, sideoats grama, and western wheatgrass. If overgrazed, the mid and tall grasses lose vigor and blue grama, buffalograss, western wheatgrass, pricklypear, and other annual and perennial weeds become the dominant species.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate rainfall is the principal hazard affecting seedlings and young trees. Seedlings can survive and grow if competing vegetation is controlled or removed by cultivation between the tree rows or by careful use of the appropriate kind of herbicide. Planting an annual cover crop between the tree rows helps to control soil blowing. Irrigation can provide supplemental moisture during periods of low rainfall.

This soil is generally suited to use as building sites. The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

The land capability units are Ilc-1, dryland, and I-6, irrigated; Silty range site; and windbreak suitability group 3.

**BnB—Bufton silty clay loam, 1 to 3 percent slopes.** This very deep, very gently sloping, well drained soil is on uplands, foot slopes, and stream terraces. The soil formed in material weathered from silty shale or colluvial and alluvial sediments weathered from shale. Areas range from 10 to 200 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 6 inches thick. The subsoil is about 22 inches thick. It is grayish brown,

firm, calcareous silty clay in the upper part; light brownish gray, firm, calcareous silty clay in the middle part; and light gray, friable, calcareous silty clay loam in the lower part. The underlying material is white, calcareous silty clay loam to a depth of more than 60 inches. In some places the surface layer is silt loam or clay loam. In other places shale is at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of Orella and Thirtynine soils. Orella soils are shallow and are on ridgetops and knolls. Thirtynine soils have a thicker dark surface layer than the Bufton soil and are higher on the landscape. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow in the Bufton soil. Available water capacity is high. Runoff is slow. The organic matter content is moderately low. Chalcedony fragments are scattered on the surface of the soil and throughout the profile.

Most of the acreage of this soil is used for range. The rest is used mainly for dryland crops or for hay and pasture.

If dryland farmed, this soil is suited to wheat, alfalfa, and oats. Water erosion and the lack of seasonal rainfall are the main hazards. A system of conservation tillage, such as ecofallow or discing, that leaves all or part of the crop residue on the surface helps to conserve soil moisture and control erosion. Terraces and contour farming help to control water erosion.

If irrigated, this soil is suited to alfalfa, small grains, and introduced grasses. Water can be applied by sprinkler or gravity systems. Land leveling is needed for gravity irrigation. A system of conservation tillage that keeps crop residue on the surface helps to control erosion and conserve soil moisture.

If this soil is used as range, the climax vegetation is dominated by little bluestem, sideoats grama, blue grama, western wheatgrass, needleandthread, and threadleaf sedge. These species make up 70 percent or more of the total annual production. Buffalograss, green needlegrass, prairie sandreed, and other annual and perennial grasses, forbs, and shrubs make up the remaining 30 percent. If subject to continuous heavy grazing, little bluestem and western wheatgrass decrease in abundance. Initially, these species are replaced by blue grama, hairy grama, prairie sandreed, sand dropseed, needleandthread, plains muhly, Sandberg bluegrass, sedges, annual grasses, and forbs. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive.

If the range is in excellent condition, the suggested

initial stocking rate is 0.6 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. Properly locating fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time salt is provided help to prevent excessive trampling and local overuse. Proper grazing use is very effective in controlling soil erosion. Areas previously used as cropland should be reseeded to a suitable grass mixture.

If this soil is used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be only used as fall or winter range. The production of hay can be increased by using contour ditches to spread irrigation water on this soil. Timely application and efficient distribution of water may be difficult because of the uneven slopes.

This soil is suited to introduced grasses or legumes used as pasture or hayland. These grasses can be rotated with other crops. Such cool-season grasses as crested wheatgrass, intermediate wheatgrass, and western wheatgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or clover. This soil is subject to water erosion. Continuous heavy grazing causes poor plant vigor and results in the formation of rills after heavy rains. Rotation grazing and proper stocking rates help keep the grasses in good condition. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is poorly suited to the trees and shrubs planted in windbreaks. The high content of clay, water erosion, and droughtiness are limitations. The soil should be prepared for planting when it is moist but not wet. Sites may be prepared by tillage or a combination of chemicals and tillage. A drip irrigation system can provide supplemental moisture during periods of low rainfall. Planting the trees on the contour helps to control water erosion. The undesirable weeds and grasses can be controlled by cultivation with conventional equipment between the tree rows. The appropriate kind of herbicide can be applied in areas in the rows. Areas can be hoed by hand or rototilled.

Because of the moderately slow permeability, this soil is poorly suited to septic tank absorption fields. Enlarging the absorption field or installing an alternative system helps to ensure that the absorption field functions properly. Strengthening the foundations

of buildings and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling. Mixing the base material for roads and streets with additives, such as hydrated lime, can help to prevent shrinking and swelling. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

The land capability units are IIIe-1, dryland, and IIIe-3, irrigated; Clayey range site; and windbreak suitability group 4L.

**BnE—Bufton silty clay loam, 9 to 20 percent slopes.** This very deep, moderately steep, well drained soil is on uplands. This soil formed in material weathered from silty shale. Areas range from 5 to 200 acres in size.

Typically, the surface layer is dark grayish brown, friable silty clay loam about 4 inches thick. The subsoil is firm, calcareous silty clay loam about 20 inches thick. The upper part is brown, and the lower part is light gray. The underlying material to a depth of more than 60 inches is light gray, calcareous silt loam. In some places the surface layer is silt loam, clay loam, or silty clay. In other places lime is leached to a depth of 6 inches or more. In some areas shale is at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of Enning, Minnequa, and Orella soils. The included soils are on similar landscapes as the Bufton soil. Enning and Orella soils are shallow. Minnequa soils are moderately deep. Enning and Minnequa soils formed in material weathered from interbedded chalk and shale. Orella soils formed in material weathered from shale. Included soils make up 5 to 25 percent of the unit.

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

All of the acreage of this soil is used as rangeland. This soil is not suited to cropland because of the steep slopes.

If this soil is used as range, the climax vegetation is dominated by little bluestem, sideoats grama, western wheatgrass, blue grama, needleandthread, and threadleaf sedge. These species make up 70 percent or more of the total annual production. Buffalograss, green needlegrass, prairie sandreed, and other annual and perennial grasses, forbs, and shrubs make up the remaining 30 percent. If subject to continuous heavy grazing, little bluestem and western wheatgrass decrease in abundance. Initially, these species are

replaced by blue grama, hairy grama, prairie sandreed, sand dropseed, needleandthread, plains muhly, Sandberg bluegrass, sedges, annual grasses, and forbs. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.6 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. Properly locating fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time salt is provided help to prevent excessive trampling and local overuse.

Proper grazing use is very effective in controlling soil erosion. Areas previously used as cropland should be reseeded to a suitable grass mixture. In areas where gullies have formed because of severe water erosion, land shaping or mechanical practices may be required in addition to deferment to stabilize the area.

If this soil is used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be only used as fall or winter range.

This soil is poorly suited to the trees and shrubs planted in windbreaks. The soil should be prepared for planting when it is moist but not wet. Sites may be prepared by tillage or a combination of chemicals and tillage. Irrigation can provide supplemental moisture during periods of low rainfall. The undesirable weeds and grasses can be controlled by cultivation with conventional equipment. Annual cover crops can be planted between the tree rows. The appropriate kind of herbicide can be used in areas in the rows. Some areas can be hoed by hand or rototilled. Planting the trees on the contour helps to conserve moisture and prevent excessive runoff and erosion. Light cultivation and supplemental watering closes the cracks caused by shrinking and swelling and thus helps protect the roots from exposure.

Because of the moderately slow permeability and the slope, this soil is poorly suited to septic tank absorption fields. In areas where the slope is less than 15 percent, enlarging the absorption field, land shaping, and installing the field on the contour helps to ensure that the absorption field functions properly. In areas where the slope is more than 15 percent, the soil is generally not suited to sanitary facilities. A

suitable alternative site should be selected. Strengthening the foundations of buildings and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling. Dwellings and buildings also need to be properly designed so that they conform to the natural slope of the land, or the soil can be graded to a suitable gradient. Mixing the base material for roads and streets with additives, such as hydrated lime, can help to prevent shrinking and swelling. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance. Cutting and filling generally can provide a suitable grade for roads and streets.

The land capability unit is VIe-1, dryland; Clayey range site; and windbreak suitability group 4L.

**BoD—Bufton-Orella complex, 3 to 9 percent slopes.** These gently sloping and strongly sloping, well drained soils are on uplands. The Bufton soil is very deep, and the Orella soil is shallow. They formed in material weathered from shale. The Bufton soil is on the lower side slopes and broad ridgetops. The Orella soil is on shoulders and on narrow ridgetops and knolls. Areas range from 20 to 200 acres in size. They consist of 60 to 80 percent Bufton soil and 20 to 40 percent Orella soil. These soils are so intermingled or mixed that separating them in mapping is not practical.

Typically, the Bufton soil has a surface layer of grayish brown, friable silty clay loam about 5 inches thick. The subsoil is about 18 inches thick. It is light brownish gray and light gray, firm, calcareous silty clay in the upper part and light gray, firm, calcareous silty clay loam in the lower part. The underlying material to a depth of more than 60 inches is light gray silty clay loam. In some places the surface layer is silt loam or clay loam. In other places shale is at a depth of 40 to 60 inches.

Typically, the Orella soil has a surface layer of grayish brown, firm silty clay loam about 5 inches thick. The transitional layer is light brownish gray, firm, calcareous silty clay loam about 5 inches thick. The underlying material is light gray, calcareous silty clay loam to a depth of 16 inches. Below this to a depth of more than 60 inches is white, silty shale. The Orella soil has a high content of sodium. In some places the surface layer is clay loam or silty clay.

Included with these soils in mapping are small areas of Epping and Thirtynine soils, which formed in material weathered from siltstone. The included soils have less clay than the Bufton and Orella soils. Thirtynine soils have a thicker dark surface layer than

the Bufton and Orella soils. Included soils make up 10 to 15 percent of the unit.

Permeability is moderately slow in the Bufton soil and very slow in the Orella soil. Available water capacity is high in the Bufton soil and very low in the Orella soil. The organic matter content is moderately low in the Bufton soil and low in the Orella soil. Runoff is medium.

Nearly all of the acreage of these soils support native grasses and are used as range. A few small areas are used as dry-farmed cropland.

If dryland farmed, the Bufton soil is poorly suited to wheat, alfalfa, and oats. Water erosion is the main hazard. A system of conservation tillage that leaves crop residue on the surface helps to conserve soil moisture and control erosion. The shallow depth to bedrock in the Orella soil makes terracing these soils difficult.

If irrigated by a sprinkler system, the Bufton soil is suited to small grains, alfalfa, and introduced grasses. It is too steep for gravity irrigation. Management is similar to that used if this soil is dryland farmed.

The Orella soil is too shallow and droughty for use as cropland.

If the Bufton soil is used as range or hayland, the climax vegetation is dominantly little bluestem, western wheatgrass, sideoats grama, blue grama, needleandthread, and threadleaf sedge. These species make up 70 percent or more of the total annual forage. Buffalograss, green needlegrass, prairie sandreed, and forbs make up the rest. The climax vegetation on the Orella soil is dominantly buffalograss, western wheatgrass, and blue grama. These species make up 60 percent or more of the total annual forage. Sideoats grama, alkali sacaton, grasslike plants, and forbs make up the rest. If subject to continuous heavy grazing, western wheatgrass and little bluestem decrease in abundance on the Bufton soil and western wheatgrass and alkali sacaton decrease in abundance on the Orella soil. They are replaced by blue grama, buffalograss, needleandthread, plains muhly, threadleaf sedge, and forbs on the Bufton soil and inland saltgrass, blue grama, hairy grama, threadleaf sedge, and forbs on the Orella soil. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, water erosion is excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.6 animal unit month per acre on the Bufton soil and 0.2 animal unit month per acre on the Orella soil. The stocking rate is determined by the percentage of each soil in the pasture. The range should be closely monitored during use and the

stocking rates adjusted so that one soil does not become overgrazed.

A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. The slope can hinder the movement of livestock. Brush management may be needed in some areas to control the woody plants that invade the site. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range. In some areas other mechanical practices may be needed to smooth and stabilize the site before it is reseeded.

If these soils are used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range.

The Bufton soil is poorly suited to the trees and shrubs planted in windbreaks. The lack of adequate rainfall and the high content of clay are the principal hazards affecting seedlings and young trees. Seedlings can survive and grow if competing vegetation is controlled or removed by cultivation between the tree rows or by careful use of the appropriate kind of herbicide. Planting an annual cover crop between the tree rows helps to control soil blowing. Irrigation can provide supplemental moisture during periods of low rainfall. The Orella soil is generally not suited to the trees and shrubs planted in windbreaks because of the shallow depth to bedrock and the very low available water capacity. Onsite investigation is needed to identify the areas best suited to windbreaks.

In areas of the Bufton soil, the moderately slow permeability is a limitation affecting septic tank absorption fields, but increasing the size of the absorption field generally can overcome this limitation. Land shaping and installing the absorption field on the contour are generally necessary for its proper operation. Sanitary facilities are generally not suited to the Orella soil because of the shallow depth to shale. A suitable alternative site should be selected. The Bufton and Orella soils are poorly suited to building sites. Strengthening the foundations of buildings and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling. In areas of the Orella soil, the soft bedrock can be excavated during the construction of dwellings with basements or buildings that have deep foundations. Mixing the base material with additives, such as hydrated lime, minimizes the damage to roads caused by shrinking and swelling. Roads built on this soil

should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance. Onsite investigation is needed before any engineering practices are applied.

The land capability units are IVE-1, dryland, and IVE-3, irrigated, for the Bufton soil and VIs-4, dryland, for the Orella soil. The Bufton soil is in the Clayey range site and windbreak suitability group 4L. The Orella soil is in the Saline Upland range site and windbreak suitability group 10.

**BsB—Busher fine sandy loam, 0 to 3 percent slopes.**

This deep, nearly level and very gently sloping, well drained soil is on uplands. The soil formed in material weathered from calcareous sandstone. Areas range from 5 to 225 acres in size.

Typically, the surface layer is dark grayish brown, friable fine sandy loam about 7 inches thick. The subsurface layer is dark grayish brown, friable fine sandy loam about 7 inches thick. The subsoil is friable fine sandy loam about 16 inches thick. It is grayish brown in the upper part and light brownish gray and calcareous in the lower part. The underlying material to a depth of 45 inches is light gray, calcareous fine sandy loam. Below this to a depth of more than 60 inches is white, calcareous sandstone. In some places the dark surface layer is less than 7 inches thick. In other places the surface layer is loamy very fine sand or very fine sandy loam.

Included with this soil in mapping are small areas of Jayem, Tassel, and Vetal soils. Jayem soils do not have sandstone within a depth of 60 inches and are on similar landscapes as the Busher soil. Tassel soils have calcareous sandstone at a depth of 6 to 20 inches and are on convex knolls that are higher on the landscape than the Busher soil. Vetal soils have a dark surface soil thicker than 20 inches and do not have sandstone within a depth of 60 inches. These soils are lower on the landscape than the Busher soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Busher soil, and available water capacity is moderate. The organic matter content is moderately low. Runoff is slow. The water intake rate is moderately high.

Most of the acreage of this soil is farmed. The rest is used for range. The cultivated areas are either dryland farmed or irrigated.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Soil blowing is the principal hazard in areas where the surface is not adequately

protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, help to prevent soil blowing. Because of the moderate available water capacity, these tillage practices also help to conserve soil moisture. Cover crops also help to control erosion. Returning crop residue to the soil helps improve the organic matter content and the water intake rate.

If irrigated, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. This soil is best suited to sprinkler irrigation because of the moderately high water intake rate. Some land leveling is generally needed if gravity systems are used so that water movement and intake rate are uniform. Soil blowing is the principal hazard. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue and green manure crops into the soil helps improve the organic matter content, fertility, and tilth. The efficient use of irrigation water is a management concern because excessive amounts of water leach plant nutrients below the root zone.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, or legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. This soil is subject to water erosion. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Continuous heavy grazing and improper haying also reduce the amount of protective cover and can result in soil blowing and the formation of small gullies and rills after heavy rains. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants

is effective in controlling soil blowing and water erosion. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. As a result, soil blowing is excessive and small blowouts can form. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs planted in windbreaks. Soil blowing is the main hazard affecting the establishment of windbreaks. It can be controlled by maintaining strips of sod or a cover crop between the tree rows. The weeds and undesirable grasses in the tree rows can be controlled by the careful use of the appropriate kind of herbicide or hoeing by hand. Cultivation between the rows with conventional equipment can control undesirable grasses and weeds in areas where strips of sod and cover crops are not used. The lack of adequate rainfall in summer is also a hazard affecting the survival of young trees. Irrigation can provide supplemental moisture during periods of low rainfall.

The use of this soil for septic tank absorption fields is limited by depth to bedrock. Mounding the sites for absorption fields on several feet of suitable fill material improves the filtering capacity of the soil. The sides of shallow excavations can cave in unless they are shored. This soil is generally suited to building sites and roads.

The land capability units are 11le-3, dryland, and 11e-8, irrigated; Sandy range site; and windbreak suitability group 5.

**BsC—Busher fine sandy loam, 3 to 6 percent slopes.** This deep, gently sloping, well drained soil is on uplands. The soil formed in material weathered from calcareous sandstone. Areas range from 5 to 130 acres in size.

Typically, the surface layer is grayish brown, friable fine sandy loam about 4 inches thick. The subsurface layer is brown, friable fine sandy loam about 7 inches thick. The subsoil is pale brown, friable fine sandy loam about 9 inches thick. The underlying material to a depth of 44 inches is fine sandy loam. The upper part is pale brown, and the lower part is light gray and calcareous. Below this to a depth of more than 60 inches is white, calcareous sandstone. In cultivated areas 15 to 30 percent of this soil is eroded. In these areas erosion has removed all or most of the original surface soil, and tillage has mixed the remaining surface soil with the subsoil. In some places the

surface layer is light in color and calcareous. In other places the surface layer is very fine sandy loam or loamy very fine sand.

Included with this soil in mapping are small areas of Jayem, Satanta, Tassel, and Tuthill soils. Jayem soils do not have sandstone within a depth of 60 inches and are on similar landscapes as the Busher soil. Satanta and Tuthill soils have more clay in the subsoil than the Busher soil and are not underlain by sandstone. These soils are on similar landscapes. Tassel soils are 6 to 20 inches deep to calcareous sandstone and are slightly higher on the landscape than the Busher soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Busher soil, and available water capacity is moderate. Organic matter content is moderately low. Runoff is slow. The water intake rate is moderately high.

Most of the acreage of this soil is farmed. The rest is used for range. The cultivated areas are either dryland farmed or irrigated.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Water erosion and soil blowing are the principal hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, help to control soil blowing and water erosion and conserve soil moisture. Cover crops help reduce runoff and control erosion. Terracing and contour farming are also effective in controlling water erosion and conserving soil moisture. Returning crop residue to the soil helps improve the organic matter content and the water intake rate.

If irrigated by a sprinkler system, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. This soil is poorly suited to gravity irrigation systems because of the moderately high water intake rate and the slope. Soil blowing and water erosion are the principal hazards. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control water erosion and soil blowing and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water leach plant nutrients below the root zone and result in the hazard of water erosion on the slopes.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent

wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. This soil is subject to water erosion. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants is very effective in controlling soil blowing and water erosion. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. As a result, soil blowing is excessive and small blowouts can form. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs planted in windbreaks. Erosion is the main hazard affecting the establishment of windbreaks. Water erosion and soil blowing can be controlled by maintaining strips of sod or a cover crop between the tree rows. The weeds and undesirable grasses in the tree rows can be controlled by the careful use of the appropriate kind of herbicide or hoeing by hand. Cultivation between the tree rows with conventional equipment can control undesirable grasses and weeds in areas where strips of sod and cover crops are not used. The lack of adequate rainfall in summer is also a hazard affecting the survival of young trees. Irrigation can provide supplemental moisture during periods of low rainfall.

The use of this soil for septic tank absorption fields is limited by depth to bedrock. Mounding the sites for absorption fields on several feet of suitable fill material improves the filtering capacity of the soil. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. The sides of shallow excavations can cave in unless they are shored. This soil is generally suited to roads.

The land capability units are IIIe-3, dryland, and

Ille-8, irrigated; Sandy range site; and windbreak suitability group 5.

**BsD—Busher fine sandy loam, 6 to 9 percent slopes.** This deep, strongly sloping, well drained soil is on uplands. The soil formed in material weathered from calcareous sandstone. Areas range from 5 to 200 acres in size.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 12 inches thick. The subsoil is grayish brown, very friable fine sandy loam about 8 inches thick. The underlying material to a depth of 42 inches is white, calcareous fine sandy loam. Below this to a depth of more than 60 inches is white, calcareous sandstone. In some places the surface layer is loamy very fine sand or loamy fine sand. In some areas the sandstone is at a depth of 20 to 40 inches. In cultivated areas 20 to 35 percent of this soil is eroded. In these areas erosion has removed all or most of the original surface soil, and tillage has mixed the remaining surface soil with the subsoil. In most places the surface layer is light in color and calcareous.

Included with this soil in mapping are small areas of Jayem, Satanta, Tassel, Tuthill, and Valent soils. Jayem soils do not have sandstone within a depth of 60 inches and are on similar landscapes as the Busher soil. Satanta and Tuthill soils have more clay in the subsoil than the Busher soil and are not underlain by sandstone. These soils are on similar landscapes. Tassel soils are 6 to 20 inches deep to calcareous sandstone and are higher on the landscape than the Busher soil. Valent soils have more sand than the Busher soil and are not underlain by sandstone. These soils are higher on the landscape. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Busher soil, and available water capacity is moderate. The organic matter content is moderately low. Runoff is medium. The water intake rate is moderately high.

Most of the acreage of this soil is used as rangeland. The rest is farmed. Most of the cultivated areas are used for dryland farming, but a few areas are irrigated.

If dryland farmed, this soil is poorly suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be grown. Water erosion and soil blowing are the principal hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, help to control soil blowing and water erosion. Because of the moderate available water capacity, these tillage practices also help to

conserve soil moisture. Stripcropping, terraces, and annual cover crops help to control soil blowing and water erosion.

If irrigated by a sprinkler system, this soil is poorly suited to corn, small grains, alfalfa, and introduced grasses. This soil is best suited to sprinkler irrigation because of the moderately high water intake rate and the slope. Soil blowing and water erosion are the principal hazards on unprotected surfaces. A system of conservation tillage, such as no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. Cover crops also help to control erosion. Returning crop residue to the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water result in the hazard of water erosion on the slopes and leach plant nutrients below the root zone.

If this soil is used for range or native hay, the climax vegetation is dominantly prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 75 percent or more of the total annual forage. Blue grama, switchgrass, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, prairie sandreed, blue grama, Scribner panicum, sand dropseed, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. This soil is generally the first to be overgrazed in a pasture that includes the Sands or Choppy Sands range sites. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain healthy and vigorous.

This soil is suited to the trees and shrubs planted in windbreaks. Erosion is the main hazard affecting the establishment of windbreaks. Water erosion and soil blowing can be controlled by maintaining strips of sod

or a cover crop between the tree rows. The weeds and undesirable grasses in the tree rows can be controlled by the careful use of the appropriate kind of herbicide or hoeing by hand. Cultivation between the tree rows with conventional equipment can control undesirable grasses and weeds in areas where strips of sod and cover crops are not used. The lack of adequate rainfall in summer is also a hazard affecting the survival of young trees. Irrigation can provide supplemental moisture during periods of low rainfall.

The use of this soil for septic tank absorption fields is limited by depth to bedrock. Mounding the sites for absorption fields on several feet of suitable fill material improves the filtering capacity of the soil. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. The sides of shallow excavations can cave in unless they are shored. This soil is generally suited to roads.

The land capability units are IVe-3, dryland, and IVe-8, irrigated; Sandy range site; and windbreak suitability group 5.

**BvC—Busher-Tassel complex, 0 to 6 percent slopes.** These nearly level to gently sloping, well drained soils are on uplands. They formed in loamy material weathered from calcareous sandstone. The Busher soil is deep and on broad ridgetops and the lower side slopes. The Tassel soil is shallow and on the upper side slopes and narrow ridgetops. Areas range from 5 to 110 acres in size. They consist of 50 to 60 percent Busher soil and 25 to 35 percent Tassel soil. These soils are so intricately mixed that separating them in mapping is not practical.

Typically, the Busher soil has a surface layer of dark grayish brown, very friable fine sandy loam about 17 inches thick. The subsoil is grayish brown, very friable very fine sandy loam about 18 inches thick. The underlying material to a depth of 42 inches is white, calcareous fine sandy loam. Below this to a depth of more than 60 inches is calcareous sandstone. In some places the surface layer is loamy very fine sand or loamy fine sand. In some areas the sandstone bedrock is at a depth of 20 to 40 inches. In other areas the dark surface layer is less than 7 inches thick. In a few areas the subsoil is finer textured. In cultivated areas 15 to 30 percent of this soil is eroded. In these areas erosion has removed all or most of the original surface soil, and tillage has mixed the remaining surface soil with the subsoil. In most places the surface layer is light in color and calcareous.

Typically, the Tassel soil has a surface layer of dark grayish brown, very friable, calcareous fine sandy loam about 5 inches thick. The underlying material is

brown, calcareous fine sandy loam to a depth of 13 inches. Below this is white, calcareous, fine grained sandstone. In cultivated areas erosion has removed all or most of the original surface soil, and the thickness of the loamy material over the sandstone bedrock has been reduced. In these areas numerous sandstone fragments have been dislodged by tillage equipment and are on the surface. The surface layer of these areas is light in color and calcareous. In some places the surface layer is loamy fine sand or very fine sandy loam.

Included with these soils in mapping are small areas of Satanta and Valent soils and areas of rock outcrop. Satanta soils have more clay in the subsoil than the Busher and Tassel soils and do not have sandstone within a depth of 60 inches. These soils are on similar landscapes as the Busher soil. Valent soils have more sand than the Busher and Tassel soils and do not have sandstone within a depth of 60 inches. These soils are on similar landscapes as the Busher soil. Areas of rock outcrop have exposed sandstone or less than 6 inches of soil material over the sandstone and are higher on the landscape than the Busher and Tassel soils. Included soils make up 10 to 15 percent of the unit.

Permeability is moderately rapid in the Busher and Tassel soils. Available water capacity is moderate in both soils. The organic matter content is moderately low in both soils. Runoff is medium on both soils. The water intake rate is moderately high in both soils. Root development is restricted by the underlying sandstone in the Tassel soil.

Most of the acreage of these soils is used for range. The rest is used for dryland farming.

If dryland farmed, the Busher soil is suited to small grains, introduced grasses, and alfalfa. The lack of sufficient rainfall limits the cultivated crops that can be successfully grown. Soil blowing is a serious hazard. A system of conservation tillage, such as stubble mulching and ecofallow, helps to control soil blowing and conserve soil moisture. Stripcropping and planting annual cover crops are other suitable practices. Because of the shallow depth to bedrock in areas of the Tassel soil, constructing terraces is difficult. Summer fallowing conserves moisture for use during the following growing season.

If irrigated by a sprinkler system, the Busher soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. This soil is poorly suited to gravity irrigation because of the moderately high intake rate and the slope. If a gravity irrigation system is used, the soils need to be leveled to a suitable grade so that water movement and intake rate are uniform. Soil blowing and water erosion are the

principal hazards. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to prevent erosion and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water leach plant nutrients below the root zone.

The Tassel soil is too shallow and droughty for use as cropland, but in some places it is farmed along with areas of the deeper Busher soil.

These soils are suited to introduced grasses used as pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, into dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. This soil is subject to water erosion. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Continuous heavy grazing and improper haying also reduce the amount of protective cover and can result in soil blowing and the formation of small gullies and rills after heavy rains. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

If these soils are used for range or native hay, the climax vegetation on the Busher soil is dominantly prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 75 percent or more of the total annual forage. Blue grama, switchgrass, and forbs make up the rest. The climax vegetation on the Tassel soil is dominantly little bluestem, sideoats grama, western wheatgrass, blue grama, hairy grama, sand bluestem, big bluestem, and threadleaf sedge. These species make up 60 percent or more of the total annual forage. Prairie sandreed, needleandthread, green needlegrass, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance on the Busher soil and little bluestem and switchgrass decrease in abundance on

the Tassel soil. They are replaced by needleandthread, prairie sandreed, blue grama, Scribner panicum, sand dropseed, and forbs on the Busher soil and sideoats grama, blue grama, hairy grama, prairie sandreed, sand dropseed, threadleaf sedge, and forbs on the Tassel soil. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive. Woody plants may invade the site on the Tassel soil.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre on the Busher soil and 0.5 animal unit month per acre on the Tassel soil. The stocking rate is determined by the percentage of each soil in the pasture. The range should be closely monitored during use and the stocking rates adjusted so that one soil does not become overgrazed. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If these soils are used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain healthy and vigorous.

The Busher soil is suited to the trees and shrubs planted in windbreaks. Soil blowing is the main hazard affecting the establishment of windbreaks. It can be controlled by maintaining strips of sod or a cover crop between the tree rows. The weeds and undesirable grasses in the tree rows can be controlled by the careful use of the appropriate kind of herbicide or hoeing by hand. Cultivation between the tree rows with conventional equipment can control undesirable grasses and weeds in areas where strips of sod and cover crops are not used. The lack of adequate rainfall in summer is also a hazard affecting the survival of young trees. Supplemental water may be needed during dry periods.

The Tassel soil is generally not suited to the trees and shrubs planted in windbreaks because of the shallow depth to bedrock and the moderate available water capacity. Onsite investigation is needed to identify the areas best suited to windbreaks.

In areas of the Busher soil, mounding the sites for septic tank absorption fields on several feet of suitable fill material improves the filtering capacity of the soil. The Tassel soil is generally not suited to sanitary

facilities because of the shallow depth to bedrock. The Busher soil is generally suited to building sites and roads. In areas of the Tassel soil, the soft bedrock can be excavated during the construction of dwellings with basements, buildings that have deep foundations, and roads. In areas of the Busher soil, the sides of shallow excavations can cave in unless they are shored. Onsite investigation is needed before any engineering practices are applied.

The land capability units are IIIe-3, dryland, and IIIe-8, irrigated, for the Busher soil and VIIs-4, dryland, for the Tassel soil. The Busher soil is in the Sandy range site and windbreak suitability group 5. The Tassel soil is in the Shallow Limy range site and windbreak suitability group 10.

**BvF—Busher-Tassel complex, 6 to 30 percent slopes.** These strongly sloping to steep, well drained soils are on uplands. They formed in loamy material weathered from calcareous sandstone. The deep Busher soil is on the wider ridgetops and the lower side slopes, and the shallow Tassel soil is on convex knolls and ridgetops and the upper side slopes. Areas range from 5 to 400 acres in size. They are about 40 to 60 percent Busher soil and 20 to 40 percent Tassel soil. These soils are so intricately mixed that separating them in mapping is not practical.

Typically, the Busher soil has a surface layer of very friable fine sandy loam about 10 inches thick. It is dark grayish brown in the upper part and dark brown in the lower part. The subsoil is dark brown, very friable fine sandy loam about 8 inches thick. The underlying material extends to a depth of 44 inches. The upper part is pale brown, calcareous fine sandy loam, and the lower part is white, calcareous loamy very fine sand. Below this to a depth of more than 60 inches is white, calcareous, fine grained sandstone. In places the surface layer is loamy very fine sand or loamy fine sand. In some areas the sandstone bedrock is at a depth of 20 to 40 inches. In other areas the dark surface layer is less than 7 inches thick.

Typically, the Tassel soil has a surface layer of dark grayish brown, very friable, calcareous fine sandy loam about 3 inches thick. The underlying material is light brownish gray, calcareous fine sandy loam to a depth of about 10 inches. Below this to a depth of more than 60 inches is white, calcareous, fine grained sandstone. In some places the surface layer is loamy fine sand or very fine sandy loam.

Included with these soils in mapping are small areas of Satanta, Vetal, and Valent soils and areas of rock outcrop. Satanta, Valent, and Vetal soils do not have calcareous sandstone within a depth of 60 inches. Satanta and Valent soils are on similar

landscapes as the Busher soil. Vetal soils have a dark surface soil more than 20 inches thick and are on the lower foot slopes and in swales. Areas of rock outcrop have exposed sandstone bedrock or less than 6 inches of soil material over bedrock and are higher on the landscape than the Busher and Tassel soils. Included soils make up 15 to 20 percent of the unit.

Permeability is moderately rapid in the Busher and Tassel soils. Available water capacity is moderate in the Busher soil and very low in the Tassel soil. Runoff is rapid. The organic matter content is moderately low in both soils. Root development is restricted by the underlying bedrock in the Tassel soil.

Nearly all of the acreage of these soils is used as rangeland. These soils are not suitable for farming because of the steep slope and the shallow root zone of the Tassel soil.

If these soils are used for range or native hay, the climax vegetation on the Busher soil is dominantly prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 75 percent or more of the total annual forage. Blue grama, switchgrass, and forbs make up the rest. The climax vegetation on the Tassel soil is dominantly sand bluestem, needleandthread, and little bluestem. These species make up 45 percent or more of the total annual forage. Blue grama, prairie sandreed, switchgrass, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance on the Busher soil and little bluestem and switchgrass decrease in abundance on the Tassel soil. They are replaced by needleandthread, prairie sandreed, blue grama, Scribner panicum, sand dropseed, and forbs on the Busher soil and sideoats grama, blue grama, hairy grama, prairie sandreed, sand dropseed, threadleaf sedge, and forbs on the Tassel soil. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive. Woody plants may invade the site on the Tassel soil.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre on the Busher soil and 0.5 animal unit month per acre on the Tassel soil. The stocking rate is determined by the percentage of each soil in the pasture. The range should be closely monitored during use and the stocking rates adjusted so that one soil does not become overgrazed. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a

more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If these soils are used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain healthy and vigorous.

These soils are generally not suited to the trees and shrubs planted in windbreaks because of the slope and the shallow depth to bedrock in areas of the Tassel soil. A few areas can be used for the trees and shrubs that enhance recreational areas or wildlife habitat if they are planted by hand or if other special management is used.

These soils are generally not suited to sanitary facilities because of the slope and the shallow depth to bedrock in areas of the Tassel soil. A suitable alternative site should be selected. Dwellings and buildings need to be properly designed so that they conform to the natural slope of the land, or the soil can be graded to an acceptable gradient. In areas of the Tassel soil, the soft bedrock can be excavated during the construction of dwellings with basements or buildings that have deep foundations. In areas of the Busher soil, the sides of shallow excavations can cave in unless they are shored. Cutting and filling generally can provide a suitable grade for roads. The soft bedrock can be excavated during the construction of roads in areas of the Tassel soil. Onsite investigation is needed before any engineering practices are applied.

The land capability unit is VIe-3, dryland, for the Busher soil and VIIs-4, dryland, for the Tassel soil. The Busher soil is in the Sandy range site and windbreak suitability group 10. The Tassel soil is in the Shallow Limy range site and windbreak suitability group 10.

**Ca—Calamus loamy fine sand, 0 to 2 percent slopes.** This very deep, nearly level, moderately well drained soil is on bottom land along the Niobrara River and its tributaries. It is subject to rare flooding. This soil formed in sandy alluvium. Areas range from 5 to 75 acres in size.

Typically, the surface layer is grayish brown, very friable loamy fine sand about 9 inches thick. The transitional layer is light brownish gray, loose fine sand about 9 inches thick. The underlying material is light gray fine sand to a depth of more than 60 inches. The lower part has strata of grayish brown fine sandy loam and loamy fine sand and yellowish brown mottles. In some places the surface layer is fine sand or loamy sand. In other places the soil is calcareous throughout the profile.

Included with this soil in mapping are small areas of Almeria and Bolent soils. Almeria soils are very poorly drained and are lower on the landscape than the Calamus soil. Bolent soils are somewhat poorly drained and are lower on the landscape than the Calamus soil. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Calamus soil, and available water capacity is low. The organic matter content is low. Runoff is slow. The water intake rate is very high. The seasonal high water table ranges from a depth of about 3 feet during wet years to about 6 feet during dry years.

Most areas of this soil are used as range or hayland. A few areas along the Niobrara River are covered by trees and shrubs. The dominant vegetation is cottonwood, green ash, and buckbrush.

This soil is too droughty for dryland farming.

If irrigated by a sprinkler system, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. This soil is too sandy for gravity irrigation. Soil blowing is the principal hazard. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone. This soil needs timely applications of irrigation water because of the low available water capacity.

If this soil is used as range or hayland, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, needleandthread, and switchgrass. These species make up 75 percent or more of the total annual forage. Blue grama, prairie junegrass, bluegrass, indiangrass, sedges, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, indiangrass, little bluestem, and switchgrass decrease in abundance and are replaced by prairie sandreed, needleandthread, sand dropseed, blue grama, sedges, and forbs. If overgrazing continues for many years, blue grama, sand dropseed, needleandthread, Scribner panicum, sedges, and forbs dominate the site. Under these conditions, the native plants lose vigor and are unable to stabilize the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition.

Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, mowing should be regulated so that the grasses remain healthy and vigorous. The forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range.

This soil is suited to the trees and shrubs planted in windbreaks. Soil blowing is the main hazard affecting the establishment of windbreaks. Trees need to be planted in shallow furrows with as little disturbance of the soil as possible. Soil blowing can be controlled by maintaining strips of sod or a cover crop between the tree rows. The weeds and undesirable grasses in the tree rows can be controlled by careful use of the appropriate kind of herbicide or hoeing by hand. The lack of adequate rainfall in summer is also a hazard affecting the survival of young trees. Irrigation can provide supplemental moisture during periods of low rainfall.

The hazard of rare flooding needs to be considered if this soil is used for sanitary facilities and building sites. This soil easily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in pollution of the ground water. A suitable alternative site should be selected. Constructing dwellings and buildings on raised, well compacted fill material helps to prevent the damage caused by floodwater. Constructing roads on suitable, well compacted fill material above the flood level, providing adequate side ditches, and installing culverts help protect roads from the damage caused by floodwater. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. The shoring should take place during dry periods.

The land capability units are V1e-5, dryland, and IVe-11, irrigated; Sandy range site; and windbreak suitability group 7.

**Cr—Crowther loam, 0 to 1 percent slopes.** This very deep, nearly level, poorly drained soil is in sandhill valleys. It formed in calcareous loamy and sandy alluvium. It is subject to rare flooding. Areas range from 20 to 100 acres in size.

Typically, the surface layer is gray, calcareous loam 3 inches thick. The subsurface layer is light gray, friable, calcareous clay loam and loam about 15 inches thick. The transitional layer is light gray, mottled, very friable, calcareous sandy clay loam about 10

inches thick. The underlying material is light gray, mottled fine sand to a depth of more than 60 inches. In some places the solum is 8 to 20 inches thick. In some areas this soil is very poorly drained. In other areas the underlying material has strata of fine sandy loam.

Included with this soil in mapping are small areas of the coarser textured and better drained Els and Wildhorse soils, which are slightly higher on the landscape than the Crowther soil. Also included are Marlake soils in small depressions in areas where the water table is above the surface for most of the growing season. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the solum in the Crowther soil and rapid in the underlying material. Available water capacity is moderate. The organic matter content is very high. Runoff is very slow. The seasonal high water table ranges from the surface during wet years to a depth of about 1.5 feet during dry years. It can recede to a depth of 3.5 to 4.5 feet in late summer in some places.

All of the acreage of this soil is used for grazing or hayland (fig. 10). This soil is not suited to farming because of the wetness caused by the seasonal high water table.

If this soil is used as range or hayland, the climax vegetation is dominantly big bluestem, indiangrass, prairie cordgrass, and switchgrass. These species make up 60 percent or more of the total annual forage. Sedges, rushes, bluegrass, slender wheatgrass, and forbs make up the rest. If subject to continuous heavy grazing or improperly harvested for hay, big bluestem, prairie cordgrass, switchgrass, and indiangrass decrease in abundance and are replaced by slender wheatgrass, western wheatgrass, plains muhly, and sedges. If overgrazing or improper haying continues for many years, bluegrass, western wheatgrass, sedges, rushes, and forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 1.8 animal unit months per acre. A planned grazing system that includes proper grazing use, timely deferments from grazing and haying, and restricted use during wet periods helps to maintain or improve the range condition. Areas of this soil are generally the first to be overgrazed in a pasture that includes the better drained, sandy soils. Properly located fences and livestock watering and salting facilities result in a more uniform distribution of grazing. During wet periods, grazing and operating heavy machinery cause surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. Large



Figure 10.—A native hay meadow in an area of Crowther loam, 0 to 1 percent slopes.

meadows can be divided into three sections and the sections mowed in rotation. The order in which the sections are mowed should be changed in successive years. After the ground is frozen, livestock can graze without damaging the meadows. They should be removed in the spring before the ground thaws and the water table reaches a high level.

This soil is suited to the trees and shrubs planted in windbreaks if the species selected can tolerate the occasional wetness. The main limitation affecting the establishment of windbreaks is the wetness caused by the high water table. Tilling the soil and planting seedlings should be delayed until after the soil has begun to dry. The weeds and undesirable grasses can be controlled by cultivation between the tree rows with conventional equipment and by the use of the appropriate kind of herbicide in the tree rows.

This soil is not suited to septic tank absorption fields or building sites because of the wetness and the rare flooding. A suitable alternative site should be

selected. The sides of shallow excavations can cave in unless they are shored. The shoring should take place during dry periods. Constructing roads on suitable, well compacted fill material above the flood level, providing adequate side ditches, and installing culverts help protect roads from the damage caused by wetness and flooding. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

The land capability unit is Vw-7, dryland; Wet Subirrigated range site; and windbreak suitability group 2D.

**Cs—Crowther loam, wet, 0 to 1 percent slopes.**

This very deep, nearly level, very poorly drained soil is in sandhill valleys. It formed in calcareous loamy and sandy alluvium. It is subject to rare flooding. It is occasionally ponded by water from the seasonal high

water table in the spring during wet years. Areas range from 20 to 100 acres in size.

Typically, the surface layer is grayish brown, very friable, calcareous loam about 7 inches thick. The transitional layer is calcareous and about 15 inches thick. It is light gray, firm, mottled clay loam in the upper part and light gray, very friable loam in the lower part. The underlying material is calcareous to a depth of more than 60 inches. It is light brownish gray fine sand in the upper part and light gray, mottled loamy fine sand in the lower part. In some places the underlying material has strata of fine sandy loam. In some areas the solum is only 8 to 20 inches thick. In a few areas the underlying material is loam.

Included with this soil in mapping are small areas of Els and Marlake soils. Els soils have more sand than the Crowther soil. These soils are better drained and are higher on the landscape. Marlake soils are lower on the landscape than the Crowther soil and are ponded for long periods. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the solum in the Crowther soil and rapid in the underlying material. Available water capacity is moderate. The organic matter content is very high. Runoff is ponded. The seasonal high water table ranges from about 0.5 foot above the surface during wet years to a depth of about 1.0 foot during dry years. It can recede to a depth of 2 feet or more in late summer.

All of the acreage of this soil is used for grazing or hayland. This soil is not suited to farming because of the wetness caused by the high water table.

If this soil is used as range or hayland, the climax vegetation is dominantly prairie cordgrass, bluejoint reedgrass, and northern reedgrass. These species make up 65 percent or more of the total annual forage. Sedges, bluegrass, slender wheatgrass, green muhly, and forbs make up the rest. If subject to continuous heavy grazing or improperly harvested for hay, prairie cordgrass, bluejoint reedgrass, and northern reedgrass decrease in abundance and are replaced by slender wheatgrass, bluegrass, green muhly, sedges, rushes, and forbs. If overgrazing or improper haying continues for many years, bluegrass, foxtail barley, sedges, rushes, and forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 2.0 animal unit months per acre. This soil produces a high quantity of low-quality forage. A planned grazing system that includes proper grazing use, timely deferments from grazing and haying, and restricted use during wet periods helps to maintain or improve the range condition. During wet periods, grazing and operating heavy machinery can cause surface compaction and the formation of

mounds and ruts, which make grazing or harvesting hay difficult.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. In wet years, some areas of hay cannot be harvested. After the ground is frozen, livestock can graze without damaging the meadows. They should be removed in the spring before the ground thaws.

This soil is not suited to the trees and shrubs planted in windbreaks because of the wetness caused by the high water table. A few areas can be used for the trees and shrubs that enhance recreational areas or wildlife habitat if they tolerate the occasional wetness and are planted by hand or if other special management is used.

This soil is not suited to septic tank absorption fields or building sites because of the wetness and the ponding. A suitable alternative site should be selected. The sides of shallow excavations can cave in unless they are shored. The shoring should take place during dry periods. Constructing roads on suitable, well compacted fill material above the ponding level, providing adequate side ditches, and installing culverts help protect roads from the damage caused by the ponding and the wetness caused by the seasonal high water table. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

The land capability unit is Vw-7, dryland; Wetland range site; and windbreak suitability group 10.

**DuB—Dailey loamy fine sand, 0 to 3 percent slopes.** This very deep, nearly level and very gently sloping, somewhat excessively drained soil is in sandhill valleys and in the transitional area between the sandhills and the loess-mantled uplands. The soil formed in eolian sand. Areas range from 5 to 180 acres in size.

Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 9 inches thick. The subsurface layer is also dark grayish brown, very friable loamy fine sand about 6 inches thick. The transitional layer is pale brown, very friable fine sand about 11 inches thick. The underlying material is light yellowish brown and very pale brown fine sand to a depth of more than 60 inches. In some places the surface soil is more than 20 inches thick. In some areas the surface layer is fine sand or loamy sand.

Included with this soil in mapping are small areas of Jayem, Tuthill, Valent, and Vetal soils. Jayem and Tuthill soils have more silt in the profile than the Dailey soil and are well drained. These soils are on similar

landscapes. Valent soils have a dark surface layer less than 10 inches thick and are higher on the landscape than the Dailey soil. Vetal soils have more silt in the profile than the Dailey soil and have a dark surface layer more than 20 inches thick. These soils are in swales. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Dailey soil, and available water capacity is low. The organic matter content is moderately low. Runoff is slow. The water intake rate is very high.

Most of the acreage of this soil is used for range. Some areas are used for farming. These areas are mainly irrigated, but a few areas are used for dryland farming.

If dryland farmed, this soil is poorly suited to small grains, alfalfa, and introduced grasses. Inadequate rainfall in summer generally limits the cultivated crops that can be grown. Soil blowing is the principal hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, help to control soil blowing. Because of the low available water capacity, these tillage practices also help to conserve soil moisture.

If irrigated by a sprinkler system, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. This soil is too sandy for gravity irrigation. Soil blowing is the principal hazard. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue, green manure crops, and barnyard manure into the soil helps improve the organic matter content, fertility, and tilth. The efficient use of irrigation water is a management concern because excessive amounts of water leach plant nutrients below the root zone. This soil needs timely applications of water because of the low available water capacity.

If this soil is used for range, native hay, or both, the climax vegetation is dominated by prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 80 percent or more of the total annual forage. Blue grama, switchgrass, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, prairie sandreed, blue grama, Scribner panicum, sand dropseed, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, soil blowing is excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. This soil is generally the first to be overgrazed in a pasture that includes the Sands or Choppy Sands range sites. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain healthy and vigorous.

This soil is suited to the trees and shrubs planted in windbreaks. Soil blowing is the main hazard affecting the establishment of windbreaks. It can be controlled by maintaining strips of sod or a cover crop between the tree rows. The weeds and undesirable grasses in the tree rows can be controlled by careful use of the appropriate kind of herbicide or by hoeing by hand. Cultivation between the tree rows with conventional equipment can control undesirable grasses and weeds in areas where strips of sod and cover crops are not used. The lack of adequate rainfall in summer is also a hazard affecting the survival of young trees. Irrigation can provide supplemental moisture during periods of low rainfall.

This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in pollution of the ground water. This soil is generally suited to building sites and roads. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

The land capability units are IVe-5, dryland, and IVe-11, irrigated; Sandy range site; and windbreak suitability group 5.

**DuD—Dailey loamy fine sand, 3 to 9 percent slopes.** This very deep, gently sloping and strongly sloping, somewhat excessively drained soil is in the sandhills and in the transitional areas between the sandhills and the loess-mantled uplands. The soil formed in eolian sand. Areas range from 5 to 350 acres in size.

Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 14 inches thick. The transitional layer is brown, very friable fine sand about 8 inches thick. The underlying material is brown and

grayish brown fine sand to a depth of more than 60 inches. In some places the dark surface soil is more than 20 inches thick. In some areas the surface layer is fine sand or loamy sand.

Included with this soil in mapping are small areas of Jayem, Tuthill, and Valent soils. Jayem and Tuthill soils have a finer textured subsoil and are well drained. These soils are on similar landscapes as the Dailey soil. Valent soils have a dark surface layer less than 10 inches thick and are higher on the landscape than the Dailey soil. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Dailey soil, and available water capacity is low. The organic matter content is moderately low. Runoff is slow and medium. The water intake rate is very high.

Nearly all of the acreage of this soil is used for range. In a few cultivated acres irrigation is used. Soil blowing is a severe hazard. The low available water capacity is a severe limitation.

This soil is too sandy and droughty for dryland farming.

If irrigated by a sprinkler system, this soil is poorly suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. This soil is not suited to gravity irrigation systems. Soil blowing is the principal hazard. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water leach plant nutrients below the root zone. This soil needs light, frequent applications of irrigation water because of the low available water capacity.

If this soil is used for range or native hay, the climax vegetation is dominantly prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 80 percent or more of the total annual forage. Blue grama, switchgrass, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, prairie sandreed, blue grama, Scribner panicum, sand dropseed, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A

planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range.

This soil is suited to the trees and shrubs planted in windbreaks. Soil blowing is a severe hazard. Trees need to be planted in shallow furrows with as little disturbance of the soil as possible. Soil blowing can be controlled by maintaining strips of sod or cover crops between the tree rows. Insufficient rainfall in summer is a hazard affecting the survival of young trees. Irrigation can provide supplemental moisture during periods of low rainfall. The weeds and undesirable grasses in the tree rows can be controlled by careful use of the appropriate kind of herbicide or by hoeing by hand.

This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in pollution of the ground water. This soil is generally suited to roads. Buildings and dwellings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

The land capability units are V1e-5, dryland, and IVe-11, irrigated; Sandy range site; and windbreak suitability group 7.

**Dw—Duroc loam, 0 to 1 percent slopes.** This very deep, nearly level, well drained soil occurs in upland swales and on stream terraces. It is subject to rare flooding. The soil formed in local loamy alluvial and colluvial sediments and loess. Areas range from 5 to 300 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 8 inches thick. The subsurface layer is grayish brown, friable loam about 21 inches thick. The next layer is light brownish gray, friable loam about 21 inches thick. The underlying material is light gray, calcareous loam to a depth of 60 inches or more. In some places the dark surface soil is less than 20 inches thick. In other places the lower part of the dark surface soil is calcareous.

Included with this soil in mapping are small areas of Keya, Lodgepole, McCook, and Vetal soils. Keya and

Lodgepole soils have more clay in the subsoil than the Duroc soil. Keya soils are slightly higher on the landscape than the Duroc soil. Lodgepole soils are lower on the landscape and are ponded for short periods. McCook soils are stratified and are slightly lower on the landscape than the Duroc soil. Vetal soils have more sand in the profile than the Duroc soil and are on similar landscapes. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the Duroc soil, and available water capacity is high. The organic matter content is moderate. Runoff is slow. The water intake rate is moderate.

Nearly all of the acreage of this soil is farmed. Dryland farming and irrigation are used on this soil. A few small areas are used as range.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be grown. Soil blowing is a hazard in areas where the surface is not adequately protected by crops or crop residue. This soil is flooded for very brief periods, and crop damage is minimal. In some years crops benefit from the additional moisture. A system of conservation tillage, such as stubble mulching and ecofallow, helps to conserve soil moisture and control soil blowing. Cover crops also help to control erosion. Returning crop residue to the soil helps to maintain the organic matter content and improves the water intake rate.

If irrigated, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. Some land leveling is generally needed if gravity systems are used so that water movement and intake rate are uniform. Soil blowing is the principal hazard. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue into the soil helps to maintain the organic matter content and fertility. Irrigation systems need to be designed so the water application rate does not exceed the moderate intake rate of this soil. A tailwater recovery system can be used to conserve water.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures.

Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range and hayland. A cover of range plants is effective in controlling soil blowing and water erosion. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants.

This soil is suited to the trees and shrubs planted in windbreaks. Seedlings can survive and grow if competing vegetation is controlled or removed by cultivation between the tree rows or by careful use of the appropriate kind of herbicide. Planting an annual cover crop between the tree rows helps to control soil blowing. Irrigation can provide supplemental moisture during periods of low rainfall.

The hazard of rare flooding should be considered if this soil is used for sanitary facilities and building sites. The moderate permeability of this soil is a limitation affecting septic tank absorption fields, but increasing the size of the absorption field can generally overcome this limitation. Constructing dwellings and buildings on raised, well compacted fill material helps to prevent the damage caused by floodwater. Constructing roads on suitable, well compacted fill material above the flood level, providing adequate side ditches, and installing culverts help protect roads from the damage caused by floodwater. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. Mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The land capability units are 11c-1, dryland, and 1-6, irrigated; Silty Lowland range site; and windbreak suitability group 1.

**DwB—Duroc loam, 1 to 3 percent slopes.** This very deep, very gently sloping, well drained soil is on toe slopes. This soil formed in local loamy alluvial and colluvial sediments and loess. Areas range from 5 to 100 acres in size.

Typically, the surface layer is dark grayish brown, very friable loam about 6 inches thick. The subsurface layer is friable loam about 26 inches thick. The upper part is dark grayish brown, and the lower part is light brownish gray. The underlying material is light gray, calcareous loam to a depth of 60 inches or more. In some places the dark surface soil is less than 20 inches thick. A few areas have a silty clay loam subsoil and dark buried layers.

Included with this soil in mapping are small areas of Keya and Vetal soils. Keya soils have more clay in the subsoil than the Duroc soil and are slightly higher on the landscape. Vetal soils have more sand in the profile than the Duroc soil and are on similar landscapes. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the Duroc soil, and available water capacity is high. The organic matter content is moderate. Runoff is slow. The water intake rate is moderate.

Nearly all of the acreage of this soil is farmed. Dryland farming and irrigation are used on this soil. A few small areas are used as range.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Water erosion and soil blowing are hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to conserve soil moisture and control erosion. Cover crops also help to control erosion. Returning crop residue to the soil helps to maintain the organic matter content and improves the water intake rate.

If irrigated, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. Some land leveling is generally needed if gravity systems are used so that water movement and intake rate are uniform. Water erosion and soil blowing are the principal hazards. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control erosion and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue into the soil helps to maintain the organic matter content and fertility. Irrigation systems need to be designed so the water application rate does not exceed the moderate intake rate of this soil. A tailwater recovery system can be used to conserve water.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated

with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range and hayland. A cover of range plants very effectively controls soil blowing and water erosion. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and soil erosion are the principal hazards affecting seedlings and young trees. Seedlings can survive and grow if competing vegetation is controlled or removed by cultivation between the tree rows or by careful use of the appropriate kind of herbicide or hoeing by hand in the tree rows. Planting an annual cover crop between the tree rows helps to control soil blowing. Irrigation can provide supplemental moisture during periods of low rainfall.

The moderate permeability of this soil is a limitation affecting septic tank absorption fields, but increasing the size of the absorption field can generally overcome this limitation. Strengthening the foundations of buildings and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. Mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The land capability units are 11e-1, dryland, and 11e-6, irrigated; Silty range site; and windbreak suitability group 3.

**Ec—Els fine sand, calcareous, 0 to 2 percent slopes.** This very deep, nearly level, somewhat poorly drained soil is in sandhill valleys. The soil formed in eolian sand and sandy alluvium. It is subject to rare flooding. Individual areas range from 20 to 200 acres in size.

Typically, the surface layer is gray, very friable fine sand about 7 inches thick. The transitional layer is grayish brown, very friable, mottled fine sand about 6 inches thick. The underlying material is pale brown, mottled fine sand to a depth of more than 60 inches. It is calcareous throughout. In some areas the surface layer is loamy fine sand. In other areas the underlying material has strata of fine sandy loam or loamy fine sand. In a few places a dark surface soil is more than 10 inches thick.

Included with this soil in mapping are small areas of Ipage, Tryon, Valent, and Valentine soils. Ipage, Valent, and Valentine soils are better drained than the Els soil and are higher on the landscape. Tryon soils are lower on the landscape than the Els soil and are poorly drained. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Els, calcareous, soil, and available water capacity is low. The organic matter content is low. Runoff is slow. The water intake rate is very high. The seasonal high water table ranges from a depth of 1.5 feet during wet years to 3.0 feet during dry years.

Nearly all of the acreage of this soil is used as range or hayland. A few areas are used as irrigated cropland. Soil blowing and the wetness caused by the high water table are severe hazards.

This soil is not suited to dryland farming because of the hazard of soil blowing.

If irrigated by a sprinkler system, this soil is poorly suited to corn, alfalfa, and introduced grasses. This soil is too sandy for gravity irrigation systems. Soil blowing is a severe hazard on unprotected surfaces. This soil dries out slowly in the spring, and tillage and planting are delayed because of the wetness. A system of conservation tillage, such as no-till, keeps crop residue on the surface and helps to control soil blowing and conserve moisture. Cover crops also help to control soil blowing. Returning crop residue to the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water leach plant nutrients below the root zone. This

soil needs frequent applications of irrigation water because of the low available water capacity.

If this soil is used as range or hayland, the climax vegetation is dominated by big bluestem, little bluestem, indiangrass, switchgrass, and various sedges. These species make up 75 percent or more of the total annual forage. Prairie cordgrass, bluegrass, rushes, and forbs make up the rest. If subject to continuous heavy grazing or improperly harvested for hay, big bluestem, little bluestem, indiangrass, switchgrass, and prairie cordgrass decrease in abundance and are replaced by western wheatgrass, bluegrass, slender wheatgrass, green muhly, sedges, and rushes. If overgrazing or improper haying continues for many years, bluegrass, sedges, rushes, and forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 1.6 animal unit months per acre. A planned grazing system that includes proper grazing use, timely deferments from grazing and haying, and restricted use during wet periods helps to maintain or improve the range condition. Areas of this soil are generally the first to be overgrazed in a pasture that includes the better drained, sandy soils. Properly located fences and livestock watering and salting facilities result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. The hay is of best quality when the grasses are cut early. After the ground is frozen, livestock can graze without damaging the meadows. They should be removed in the spring before the ground thaws.

This soil is suited to the trees and shrubs planted in windbreaks. The main limitation affecting the establishment of windbreaks is the wetness caused by the high water table. The species selected for planting should be those that withstand the occasional wetness. Tilling and planting seedlings should be delayed until after the soil has begun to dry. The weeds and undesirable grasses can be controlled by cultivation between the tree rows with conventional equipment and by the use of the appropriate kind of herbicide in the tree rows.

The hazard of rare flooding needs to be considered if this soil is used for sanitary facilities and building sites. Constructing septic tank absorption fields on fill material raises the field a sufficient distance above the seasonal high water table. The poor filtering capacity can result in pollution of the ground water. This soil readily absorbs but does not adequately filter the

effluent from septic tank absorption fields. Constructing dwellings and buildings on raised, well compacted fill material helps to overcome the wetness caused by the high water table and helps to prevent the damage caused by floodwater. Constructing roads on suitable, well compacted fill material, providing adequate side ditches, and installing culverts help protect roads from the wetness and the damage caused by floodwater. A good surface drainage system and a gravel moisture barrier in the subgrade can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving if the excavations are made during dry periods.

The land capability units are Vle-5, dryland, and IVw-12, irrigated; Subirrigated range site; and windbreak suitability group 2S.

**Ef—Els, calcareous-Hoffland complex, 0 to 2 percent slopes.** These very deep, nearly level soils are in sandhill valleys. The Els, calcareous, soil is somewhat poorly drained, and the Hoffland soil is poorly drained. They formed in eolian sand and sandy alluvium. These soils are subject to rare flooding. Areas range from 20 to 1,000 acres in size. They consist of 55 to 70 percent Els, calcareous, soil and 25 to 40 percent Hoffland soil. These soils are so intermingled or mixed that separating them in mapping is not practical.

Typically, the Els, calcareous, soil has a surface layer of gray, loose fine sand about 7 inches thick. The transitional layer is grayish brown, very friable, mottled fine sand about 8 inches thick. The underlying material is light gray, mottled fine sand to a depth of 60 inches or more. It is calcareous throughout. In some places the surface layer is loamy fine sand. In some areas the underlying material has strata of fine sandy loam or loamy fine sand.

Typically, the Hoffland soil has a surface layer of grayish brown, very friable, calcareous fine sandy loam about 3 inches thick. The subsurface layer is light brownish gray, very friable, calcareous fine sandy loam about 4 inches thick. The transitional layer is light gray, very friable, calcareous fine sandy loam about 3 inches thick. The underlying material is light brownish gray, calcareous, mottled fine sand to a depth of about 34 inches. Below this to a depth of 60 inches or more is very pale brown fine sand. In some places the dark surface layer is less than 7 inches thick. In some areas the surface layer is loam, and in a few areas it is loamy

fine sand. In a few areas the solum is more than 20 inches thick.

Included with these soils in mapping are small areas of lpage, calcareous, and Wildhorse soils. lpage, calcareous, soils are better drained than the Els, calcareous, and Hoffland soils and are slightly higher on the landscape. Wildhorse soils have a high content of sodium and are on similar landscapes as the Els, calcareous, soil. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Els, calcareous, and Hoffland soils. Available water capacity is low in both soils. The organic matter content is low in the Els, calcareous, soil and high in the Hoffland soil. Runoff is slow on the Els, calcareous, soil and very slow on the Hoffland soil. The Els, calcareous, soil has a seasonal high water table that ranges from a depth of 1.5 feet during wet years to 3.0 feet during dry years. The Hoffland soil has a seasonal high water table that ranges from the surface during wet years to a depth of 1.5 feet during dry years.

Nearly all of the acreage of these soils is used as range and hayland.

These soils are not suited to dryland farming because of the wetness in the Hoffland soil and the severe hazard of soil blowing in the Els, calcareous, soil. The Hoffland soil is not suited to irrigation because of the wetness caused by the seasonal high water table.

If irrigated by a sprinkler system, the Els, calcareous, soil is suited to crops commonly grown in the county. Onsite investigation is needed to identify the areas that are suited to irrigation. Soil blowing is a severe hazard. A system of conservation tillage that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. Frequent, light applications of irrigation water are needed because of the low available water capacity of both soils, and they help to prevent the leaching of plant nutrients below the root zone.

If these soils are used as range or hayland, the climax vegetation on the Els, calcareous, soil is dominantly big bluestem, little bluestem, indiagrass, switchgrass, and various sedges. These species make up 75 percent or more of the total annual forage. Prairie cordgrass, bluegrass, rushes, and forbs make up the rest. The climax vegetation on the Hoffland soil is dominantly big bluestem, indiagrass, prairie cordgrass, and switchgrass. These species make up 60 percent or more of the total annual forage. Bluegrass, slender wheatgrass, sedges, rushes, and forbs make up the rest. If subject to continuous heavy grazing or improperly harvested for hay, big bluestem,

little bluestem, indiagrass, switchgrass, and prairie cordgrass decrease in abundance on both soils. They are replaced by western wheatgrass, bluegrass, slender wheatgrass, green muhly, sedges, and rushes on the Els, calcareous, soil and slender wheatgrass, western wheatgrass, plains muhly, and sedges on the Hoffland soil. Timothy, redtop, and red clover also increase in abundance if they have been overseeded on the Hoffland soil. If overgrazing or improper haying continues for many years, bluegrass, western wheatgrass, sedges, rushes, and forbs dominate the site on both soils.

If the range is in excellent condition, the suggested initial stocking rate is 1.6 animal unit months per acre on the Els, calcareous, soil and 1.8 animal unit months per acre on the Hoffland soil. The stocking rate is determined by the percentage of each soil in the pasture. The range should be closely monitored during use and the stocking rates adjusted so that one soil does not become overgrazed. A planned grazing system that includes proper grazing use, timely deferments from grazing and haying, and restricted use during wet periods helps to maintain or improve the range condition. Areas of these soils are generally the first to be overgrazed in a pasture that includes the better drained, sandy soils. Properly located fences and livestock watering and salting facilities result in a more uniform distribution of grazing. During wet periods on the Hoffland soil, grazing and operating heavy machinery cause surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If these soils are used as hayland, mowing should be regulated so that the grasses remain vigorous. The hay is of best quality when the grasses are cut early. After the ground is frozen, livestock can graze without damaging the meadows. They should be removed in the spring before the ground thaws and the water table reaches a high level.

These soils are suited to the trees and shrubs planted in windbreaks. The species selected for planting should be those that withstand the wetness. The excessive wetness caused by the high water table in areas of the Hoffland soil is the main limitation. Planting seedlings in the spring is difficult on this unit and generally should be delayed until the water table has receded below a depth of 2 feet. Competing vegetation in the tree rows also needs to be controlled by cultivation between the tree rows or by the use of the appropriate kind of herbicide.

The Hoffland soil is not suited to septic tank absorption fields and building sites because of the rare

flooding and the wetness. A suitable alternative site should be selected. In areas of the Els, calcareous, soil, the hazard of rare flooding needs to be considered if this soil is used for sanitary facilities and building sites. Constructing septic tank absorption fields on fill material in areas of the Els, calcareous, soil raises the fields a sufficient distance above the seasonal high water table. Seepage can result in pollution of the ground water. Constructing dwellings and buildings in areas of the Els, calcareous, soil on raised, well compacted fill material helps to overcome the wetness caused by the high water table and helps to prevent the damage caused by floodwater. Constructing roads on suitable, well compacted fill material above the flood level, providing adequate side ditches, and installing culverts help protect roads from the damage caused by floodwater and the wetness. A good surface drainage system and a gravel moisture barrier in the subgrade can minimize the damage to roads caused by frost action on these soils. Crowning the road by grading and providing adequate side ditches help to provide the needed surface drainage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving if the excavations are made during dry periods.

The land capability units are VIe-5, dryland, and IVw-12, irrigated, for the Els, calcareous, soil and Vw-7, dryland, for the Hoffland soil. The Els, calcareous, soil is in the Subirrigated range site and windbreak suitability group 2S. The Hoffland soil is in the Wet Subirrigated range site and windbreak suitability group 2D.

**EgB—Els, calcareous-lpage complex, 0 to 3 percent slopes.** These very deep soils are in sandhill valleys. The Els, calcareous, soil is nearly level and somewhat poorly drained, and the lpage soil is very gently sloping and moderately well drained. They formed in eolian sand and sandy alluvium. The Els, calcareous, soil is subject to rare flooding. Areas range from 20 to 200 acres in size. They consist of 55 to 65 percent Els, calcareous, soil and 30 to 40 percent lpage soil. These soils are so intermingled or mixed that separating them in mapping is not practical.

Typically, the Els, calcareous, soil has a surface layer of dark grayish brown, very friable fine sand about 8 inches thick. The transitional layer is grayish brown, loose fine sand about 6 inches thick. The underlying material to a depth of 60 inches or more is light brownish gray fine sand in the upper part, dark gray loamy fine sand in the middle part, and gray, mottled fine sand in the lower part. It is calcareous throughout. In some places the surface layer is loamy fine sand. In a few places the dark surface layer is less

than 5 inches thick. In some areas a dark surface layer is more than 10 inches thick. In other areas the profile is strongly alkaline in the lower part.

Typically, the lpage soil has a surface layer of grayish brown, very friable fine sand about 4 inches thick. The transitional layer is brown, loose fine sand about 7 inches thick. The underlying material is pale brown and light gray fine sand to a depth of 40 inches. Below this to a depth of 60 inches or more is light gray, calcareous fine sand. In some places the dark surface layer is more than 10 inches thick. In other places the surface layer is loamy fine sand.

Included with these soils in mapping are small areas of Hoffland, Valent, Valentine, and Wildhorse soils. Hoffland soils are poorly drained and are lower on the landscape than the Els, calcareous, and lpage soils. Valent and Valentine soils are excessively drained and are higher on the landscape than the Els, calcareous, and lpage soils. Wildhorse soils have a high content of sodium and are on similar landscapes as the Els, calcareous, soil. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Els, calcareous, and lpage soils. Available water capacity and the organic matter content are low in both soils. Runoff is slow. The water intake rate is very high. The Els, calcareous, soil has a seasonal high water table that ranges from a depth of 1.5 feet during wet years to 3.0 feet during dry years. The lpage soil has a seasonal high water table that ranges from a depth of 3 feet during wet years to 5 feet during dry years.

Nearly all of the acreage of these soils is used for grazing or haying. In a few small cultivated areas sprinkler irrigation is used.

These soils are not suitable for dryland farming because of droughtiness and the hazard of soil blowing.

If irrigated by a sprinkler system, these soils are poorly suited to corn, alfalfa, small grains, and introduced grasses. They are too sandy for gravity irrigation. Soil blowing is the principal hazard on unprotected soil surfaces. The wetness caused by the high water table is also a limitation on the Els, calcareous, soil. Planting and cultivation may be delayed in the spring on the Els, calcareous, soil. A system of conservation tillage that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. Returning crop residue and barnyard manure to the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is also a management concern. Light, frequent applications of water are needed because of the low available water capacity of these soils.

Excessive amounts of water leach plant nutrients below the root zone.

If these soils are used as range or hayland, the climax vegetation on the Els, calcareous, soil is dominantly big bluestem, little bluestem, indiagrass, switchgrass, and sedges. These species make up 75 percent or more of the total annual forage. Prairie cordgrass, bluegrass, rushes, and forbs make up the rest. The climax vegetation on the lpage soil is dominantly sand bluestem, little bluestem, prairie sandreed, needleandthread, and switchgrass. These species make up 75 percent or more of the total annual forage. Blue grama, prairie junegrass, bluegrass, indiagrass, sedges, and forbs make up the rest. If subject to continuous heavy grazing or improperly harvested for hay, big bluestem, little bluestem, indiagrass, switchgrass, and prairie cordgrass decrease in abundance on the Els, calcareous, soil, and sand bluestem, indiagrass, little bluestem, and switchgrass decrease in abundance on the lpage soil. They are replaced by western wheatgrass, bluegrass, slender wheatgrass, green muhly, sedges, and rushes on the Els, calcareous, soil and prairie sandreed, needleandthread, sand dropseed, blue grama, sedges, and forbs on the lpage soil. If overgrazing or improper haying continues for many years, bluegrass, sedges, rushes, and forbs dominate the site on the Els, calcareous, soil, and blue grama, sand dropseed, needleandthread, Scribner panicum, sedges, and forbs dominate the site on the lpage soil. Under these conditions the native plants lose vigor and are unable to stabilize the site.

If the range is in excellent condition, the suggested initial stocking rate is 1.6 animal unit months per acre on the Els, calcareous, soil and 0.9 animal unit month per acre on the lpage soil. The stocking rate is determined by the percentage of each soil in the pasture. The range should be closely monitored during use and the stocking rates adjusted so that one soil does not become overgrazed. A planned grazing system that includes proper grazing use, timely deferments from grazing and haying, and restricted use during wet periods helps to maintain or improve the range condition. Areas of the Els, calcareous, soil are generally the first to be overgrazed in a pasture that includes the better drained, sandy soils. Properly located fences and livestock watering and salting facilities result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If these soils are used as hayland, mowing should be regulated so that the grasses remain vigorous. The

forage on the lpage soil should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range. After the ground is frozen, livestock can graze without damaging the meadows. They should be removed in the spring before the ground thaws.

These soils are suited to the trees and shrubs planted in windbreaks. The wetness caused by the high water table and soil blowing are the main hazards. The species selected for planting in areas of the Els, calcareous, soil should be those that withstand the wetness. Tilling and planting seedlings should be delayed until after the soil has begun to dry. Trees need to be planted in shallow furrows with as little disturbance of the soil as possible. Supplemental watering can provide needed water during periods of low rainfall. The weeds and undesirable grasses in the tree rows can be controlled by cultivation with conventional equipment, the proper applications of the appropriate kind of herbicide, or hoeing by hand.

In areas of the Els, calcareous, soil, the hazard of rare flooding needs to be considered if the soil is used for sanitary facilities and building sites. Constructing septic tank absorption fields on fill material raises the fields a sufficient distance above the seasonal high water table. Protection from flooding is needed. These soils readily absorb but do not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in pollution of the ground water. The lpage soil is generally suited to sites for dwellings and buildings without basements. Constructing dwellings with basements in areas of the lpage soil and all buildings in areas of the Els, calcareous, soil on raised, well compacted fill material helps to overcome the wetness caused by the high water table and helps to prevent the damage caused by floodwater in areas of the Els, calcareous, soil. A good surface drainage system and a gravel moisture barrier in the subgrade can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. In areas of the Els, calcareous, soil, constructing roads on suitable, well compacted fill material above the flood level, providing adequate side ditches, and installing culverts help protect roads from the damage caused by the wetness and the flooding. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving if the excavations are made during dry periods. Onsite investigations are needed before any engineering practices are applied.

The land capability units are Vle-5, dryland, and IVw-12, irrigated, for the Els, calcareous, soil and Vle-5, dryland, and IVe-12, irrigated, for the lpage soil. The

Els, calcareous, soil is in the Subirrigated range site and windbreak suitability group 2S. The lpage soil is in the Sandy Lowland range site and windbreak suitability group 7.

**En—Els, calcareous-Tryon complex, 0 to 2 percent slopes.** These very deep, nearly level soils are in sandhill valleys. The Els, calcareous, soil is somewhat poorly drained, and the Tryon soil is poorly drained. They formed in eolian sand and sandy alluvium. These soils are subject to rare flooding. Areas range from 20 to 200 acres in size. They consist of 55 to 70 percent Els, calcareous, soil and 25 to 40 percent Tryon soil. These soils are so intermingled or mixed that separating them in mapping is not practical.

Typically, the Els, calcareous, soil has a surface layer of dark grayish brown, very friable fine sand about 9 inches thick. The underlying material to a depth of 60 inches is grayish brown, calcareous, mottled fine sand in the upper part and light grayish brown and light gray, mottled fine sand in the lower part. In some places the profile is strongly alkaline in the lower part. In some areas the surface layer is loamy fine sand. In other areas the underlying material has strata of fine sandy loam or loamy fine sand. In some areas a dark surface layer is more than 10 inches thick.

Typically, the Tryon soil has a surface layer of dark gray, very friable, calcareous loamy fine sand about 4 inches thick. The subsurface layer is dark grayish brown, very friable, mottled fine sand about 5 inches thick. The underlying material to a depth of 60 inches or more is light brownish gray, mottled fine sand. In places the solum and underlying material are calcareous. In a few places the soil is very poorly drained. In some areas the surface texture is loam or fine sandy loam. In a few areas the solum is more than 2 feet thick.

Included with these soils in mapping are small areas of lpage soils, which are better drained than the Els, calcareous, and Tryon soils and are slightly higher on the landscape. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Els, calcareous, and Tryon soils. Available water capacity is low in both soils. Organic matter content is low in the Els, calcareous, soil and high in the Tryon soil. Runoff is slow in the Els, calcareous, soil and very slow in the Tryon soil. The Els, calcareous, soil has a seasonal high water table that ranges from a depth of 1.5 feet during wet years to 3.0 feet during dry years. The Tryon soil has a seasonal high water table that ranges from the surface during wet years to a depth of 1.5 feet during dry years.

All of the acreage of these soils is used as range and hayland.

These soils are not suitable for dryland farming because of the wetness caused by the high water table and the hazard of soil blowing. The Tryon soil is too wet for irrigation.

If irrigated by a sprinkler system, the Els, calcareous, soil is suited to the crops commonly grown in the county. It is too sandy for gravity irrigation. Onsite investigation is needed to identify the areas that are suited to irrigation. Soil blowing is the principal hazard. The wetness caused by the high water table delays planting and cultivating in the spring. A system of conservation tillage that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. Frequent, light applications of water are needed because of the low available water capacity of these soils.

These soils are suited to range and native hay. In areas of the Els, calcareous, soil, the climax vegetation is dominated by big bluestem, little bluestem, indiagrass, switchgrass, and sedges. These species make up 75 percent or more of the total annual production. Plains bluegrass, prairie cordgrass, slender wheatgrass, western wheatgrass, rushes, and some forbs make up the remaining 25 percent. If subject to continuous heavy grazing or improper haying, big bluestem, little bluestem, indiagrass, switchgrass, and prairie cordgrass decrease in abundance. Initially, these species are replaced by sideoats grama, western wheatgrass, Kentucky bluegrass, foxtail barley, slender wheatgrass, green muhly, and various sedges and rushes. Timothy, redtop, and clovers also increase in abundance if they have been overseeded. If overgrazing or improper haying continues for many years, bluegrass, sedges, rushes, clovers, and other forbs dominate the site. During wet periods, continuous heavy grazing and operating heavy machinery can cause surface compaction and can also create small mounds and ruts, which make grazing or harvesting hay difficult.

In areas of the Tryon soil, the climax vegetation is dominated by big bluestem, indiagrass, prairie cordgrass, and switchgrass. These species make up 60 percent or more of the total annual production. Bluegrass, bluejoint reedgrass, northern reedgrass, slender wheatgrass, Canada wildrye, sedges, rushes, and forbs make up the remaining 40 percent. If subject to continuous heavy grazing or improper haying, big bluestem, bluejoint reedgrass, northern reedgrass, prairie cordgrass, switchgrass, indiagrass, and reed canarygrass decrease in abundance. Initially, these plants are replaced by slender wheatgrass, plains muhly, and various sedges. Timothy, redtop, and

clovers also increase in abundance if they have been overseeded. If overgrazing or improper haying continues for many years, bluegrass, western wheatgrass, foxtail barley, and various sedges, rushes, and forbs dominate the site. During wet periods, continuous heavy grazing and operating heavy machinery can cause surface compaction and can also create small mounds and ruts, which make grazing or harvesting hay difficult.

If the range is in excellent condition, the suggested initial stocking rate is 1.6 animal unit months per acre on the Els, calcareous, soil and 1.8 animal unit months per acre on the Tryon soil. A planned grazing system that includes proper grazing use, timely deferments from grazing and haying, and restricted use during very wet periods helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. Properly locating fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the livestock watering facilities and relocating them each time that salt is provided helps to prevent excessive trampling and local overuse.

If these soils are used as hayland, mowing should be regulated so that the grasses remain vigorous. It should be avoided between the boot stage and seed maturity. Mowing before the dominant grasses reach the boot stage allows the plants to recover. Most of the carbohydrate storage occurs between this stage and seed maturity. Since haying generally extends over a period of several weeks, large meadows can be divided into three parts and mowed in rotation. One third should be mowed 2 weeks before seed stalks appear in the dominant plants, one third at the boot stage, and one third early in the flowering period. Grazing in the three parts should be rotated in successive years. After the ground is frozen, livestock can graze without damaging the meadows. Livestock should be removed before the ground thaws in the spring and the water table reaches a high level. A proper mowing height also helps to maintain the stand of grasses and high forage production. The mowing height should not be less than 3 inches.

These soils are suited to the trees and shrubs planted in windbreaks. The excessive wetness caused by the high water table in areas of the Tryon soil is the main limitation. Planting seedlings in the spring is difficult and generally should be delayed until the water table has receded below a depth of 2 feet. Competing vegetation in the tree rows can be controlled by cultivation with conventional equipment or by the timely applications of the appropriate kind of herbicide.

The Tryon soil is not suited to septic tank absorption fields and building sites because of the flooding and the wetness. A suitable alternative site should be selected. In areas of the Els, calcareous, soil, the hazard of rare flooding needs to be considered if this soil is used for sanitary facilities and building sites. Constructing septic tank absorption fields on fill material in areas of the Els, calcareous, soil raises the fields a sufficient distance above the seasonal high water table. Seepage can result in pollution of the ground water. Constructing dwellings in areas of the Els, calcareous, soil on fill material helps to overcome the wetness caused by the high water table and helps to prevent the damage caused by floodwater. Constructing roads on suitable, well compacted fill material above the flood level, providing adequate side ditches, and installing culverts help protect roads from the damage caused by floodwater and the wetness. A good surface drainage system and a gravel moisture barrier in the subgrade can minimize the damage to roads caused by frost action on these soils. Crowning the road by grading and providing adequate side ditches help to provide the needed surface drainage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving if the excavations are made during dry periods. Onsite investigation is needed before any engineering practices are applied.

The land capability units are Vle-5, dryland, and IVw-12, irrigated, for the Els, calcareous, soil and Vw-7, dryland, for the Tryon soil. The Els, calcareous, soil is in the Subirrigated range site and windbreak suitability group 2S. The Tryon soil is in the Wet Subirrigated range site and windbreak suitability group 2D.

**Es—Elsmere loamy fine sand, 0 to 2 percent slopes.** This very deep, nearly level, somewhat poorly drained soil is in sandhill valleys. It formed in eolian sand and sandy alluvium. This soil is subject to rare flooding. Areas range from 20 to 150 acres.

Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 6 inches thick. The subsurface layer is very dark grayish brown, very friable loamy fine sand about 5 inches thick. The transitional layer is grayish brown, very friable loamy fine sand about 6 inches thick. The underlying material is light brownish gray and light gray, mottled fine sand to a depth of 60 inches or more. In some places the surface soil is less than 10 inches thick. In some areas the surface layer is loamy sand, fine sand, or fine sandy loam. In some areas the underlying material is calcareous.

Included with this soil in mapping are small areas of Dailey, Ipage, Valent, and Valentine soils. The included soils are higher on the landscape than the Elsmere soil and are moderately well drained to excessively drained. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Elsmere soil. Available water capacity is low. Runoff is slow. The organic matter content is moderately low. The seasonal high water table ranges from a depth of 1.5 feet during wet years to 3.0 feet during dry years. The water intake rate is very high.

Nearly all of the acreage of this soil is used for range or hay production. In a few cultivated areas sprinkler irrigation is used.

If dryland farmed, this soil is poorly suited to small grains and introduced grasses. Soil blowing is a serious hazard in areas where the surface is not adequately protected by crops or crop residue. The wetness caused by the high water table is also a limitation. Cover crops, no-till, and stubble mulching help to conserve soil moisture and control soil blowing. Planting and cultivating is generally delayed in the spring because of the wetness caused by the high water table. Incorporating crop residue into the soil helps to maintain and improve the fertility and the organic matter content.

If irrigated by a sprinkler system, this soil is poorly suited to corn, alfalfa, small grains, and introduced grasses. It is too sandy for gravity irrigation. Soil blowing is a serious hazard in areas where the soil is not adequately protected by crops or crop residue. The wetness in the spring is also a limitation. A system of conservation tillage that keeps crop residue on the surface or the use of cover crops helps to control soil blowing. Planting and cultivating is generally delayed in the spring because of the wetness of this soil. Incorporating crop residue into the soil helps to maintain and improve fertility and the organic matter content. This soil needs frequent applications of irrigation water because of the low available water capacity; however, excessive amounts of water leach plant nutrients below the root zone.

If this soil is used as range or hayland, the climax vegetation is dominantly big bluestem, little bluestem, indiagrass, switchgrass, and sedges. These species make up 70 percent or more of the total annual forage. Prairie cordgrass, bluegrass, rushes, and forbs dominate the rest. If subject to continuous heavy grazing or improperly harvested for hay, big bluestem, little bluestem, indiagrass, switchgrass, and prairie cordgrass decrease in abundance and are replaced by western wheatgrass, bluegrass, slender wheatgrass,

green muhly, sedges, and rushes. If overgrazing or improper haying continues for many years, bluegrass, sedges, rushes, and forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 1.6 animal unit months per acre. A planned grazing system that includes proper grazing use, timely deferments from grazing and haying, and restricted use during wet periods helps to maintain or improve the range condition. Areas of this soil are generally the first to be overgrazed in a pasture that includes the better drained, sandy soils. Properly located fences and livestock watering and salting facilities result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. The hay is of best quality when the grasses are cut early. After the ground is frozen, livestock can graze without damaging the meadows. They should be removed in the spring before the ground thaws.

This soil is suited to the trees and shrubs planted in windbreaks. The species selected should be able to tolerate the occasional wetness. The main limitation affecting the establishment of windbreaks is the wetness caused by the high water table. Tilling and planting seedlings should be delayed until after the soil has begun to dry. The weeds and undesirable grasses can be controlled by cultivation between the tree rows with conventional equipment and by the use of the appropriate kind of herbicide in the tree rows.

The hazard of rare flooding needs to be considered if this soil is used for sanitary facilities and building sites. Constructing septic tank absorption fields on fill material raises the fields a sufficient distance above the seasonal high water table. The poor filtering capacity can result in pollution of the ground water. This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving if the excavations are made during dry periods. Constructing dwellings and buildings on raised, well compacted fill material helps to overcome the wetness caused by the high water table and helps to prevent the damage caused by floodwater. A good surface drainage system and a gravel moisture barrier in the subgrade can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. Constructing roads on suitable, well compacted fill material above the level of ponding, providing adequate side ditches, and

installing culverts help protect roads from the damage caused by the wetness and the flooding.

The land capability units are IVw-5, dryland, and IVw-11, irrigated; Subirrigated range site; and windbreak suitability group 2S.

**EuE—Enning-Minnequa complex, 6 to 20 percent slopes.** These soils are shallow and moderately deep, strongly sloping to steep, and well drained. They formed in silty, calcareous material weathered from interbedded chalk and shale. The shallow Enning soil is on ridgetops, shoulders, and the steep upper side slopes. The moderately deep Minnequa soil is on the lower side slopes. Areas range from 20 to 300 acres in size. They consist of 35 to 50 percent Enning soil and 30 to 40 percent Minnequa soil. These soils are so intermingled or mixed that separating them in mapping is not practical.

Typically, the surface layer of the Enning soil is grayish brown, friable, calcareous silty clay loam about 3 inches thick. The transitional layer is light brownish gray, friable, calcareous silty clay loam about 4 inches thick. The underlying material is light gray, friable, calcareous silty clay loam to a depth of 18 inches. Below this to a depth of more than 60 inches is white, interbedded chalk and shale. In some places the surface layer is silt loam.

Typically, the surface layer of the Minnequa soil is grayish brown, friable, calcareous silty clay loam about 4 inches thick. The transitional layer is light brownish gray, friable, calcareous silty clay loam about 6 inches thick. The underlying material to a depth of 33 inches is light brownish gray, friable, calcareous silty clay loam in the upper part and light gray, very friable, calcareous silt loam in the lower part. Below this to a depth of more than 60 inches is white, interbedded chalk and shale. In some places the surface layer is silt loam or loam.

Included with these soils in mapping are small areas of Marvel and Orella soils and areas of shale outcrop. Marvel soils are very deep and are on foot slopes and alluvial fans. Orella soils are higher on the landscape than the Enning and Minnequa soils and formed in silty shale. The areas of shale outcrop are weathered and can occur on ridges. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the Enning and Minnequa soils. Available water capacity is very low in the Enning soil and low in the Minnequa soil. The organic matter content is moderately low in both soils. Runoff is rapid. Root development is restricted by the underlying interbedded chalk and shale in the Enning soil.

These soils support native grasses and are used as

range. They are not suitable for cropland because of the steep slope and the shallow depth to bedrock in the Enning soil.

If these soils are used as range, the climax vegetation on the Enning soil is dominantly little bluestem, sideoats grama, blue grama, and threadleaf sedge. These species make up 80 percent or more of the total annual forage. Prairie sandreed, western wheatgrass, hairy grama, sand bluestem, big bluestem, needleandthread, green needlegrass, and forbs make up the rest. The climax vegetation on the Minnequa soil is dominantly little bluestem, big bluestem, sideoats grama, and blue grama. These species make up 55 percent or more of the total annual forage. Plains muhly, buffalograss, needleandthread, western wheatgrass, and forbs make up the rest. If subject to continuous heavy grazing, little bluestem, sand bluestem, and big bluestem decrease in abundance on the Enning soil, and big bluestem and little bluestem decrease in abundance on the Minnequa soil. They are replaced by sideoats grama, blue grama, hairy grama, prairie sandreed, sand dropseed, threadleaf sedge, and forbs on the Enning soil and hairy grama, prairie sandreed, tall dropseed, western wheatgrass, needleandthread, plains muhly, sedges, and forbs on the Minnequa soil. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, water erosion is excessive. Woody plants may invade the site on the Enning soil.

If the range is in excellent condition, the suggested initial stocking rate is 0.5 animal unit month per acre on the Enning soil and 0.6 animal unit month per acre on the Minnequa soil. The stocking rate is determined by the percentage of each soil in the pasture. The range should be closely monitored during use and the stocking rates adjusted so that one soil does not become overgrazed. A planned grazing system that includes proper grazing use and timely deferments from grazing helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Brush management may be needed in some areas to control the woody plants that invade the site.

Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range. In areas where gullies have formed because of severe water erosion, land shaping or other mechanical practices may be needed to smooth and stabilize the site before it is reseeded.

The Enning soil is generally not suited to the trees and shrubs planted in windbreaks. The shallow depth to bedrock and the steep slope severely limit the

planting, survival, or growth of trees and shrubs. Onsite investigation may identify small areas that are suitable for windbreaks. The Minnequa soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and water erosion are the principal hazards affecting seedlings and young trees. Seedlings can survive and grow if competing vegetation is controlled or removed by good site preparation, timely cultivation between the tree rows, or by careful use of the appropriate kind of herbicide. Planting the trees on the contour and terracing help to control water erosion and excessive runoff. Irrigation can provide supplemental moisture during periods of low rainfall.

The Enning soil is generally not suitable for septic tank absorption fields because it is shallow to bedrock. A suitable alternative site should be selected. In areas of the moderately deep Minnequa soil, building up or mounding the sites for septic tank absorption fields with suitable fill material improves the filtering capacity of the soil. Buildings should be designed so that they conform to the natural slope of the land, or the soil and soft bedrock can be graded to a suitable gradient. Strengthening the foundations of buildings and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling. The soft bedrock can be excavated during the construction of roads in areas of the Enning soil. Roads need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of these soils. Coarser grained material can be used to ensure better performance. Cutting and filling can provide a suitable grade for roads.

The land capability unit is VIs-4, dryland, for the Enning soil and VIe-9, dryland, for the Minnequa soil. The Enning soil is in the Shallow Limy range site and windbreak suitability group 10. The Minnequa soil is in the Limy Upland range site and windbreak suitability group 3.

**EvG—Enning-Rock outcrop complex, 9 to 40 percent slopes.** This map unit consists of the shallow, well drained, strongly sloping to very steep Enning soil and areas of eroded exposures of interbedded chalk and shale on uplands. The Enning soil formed in silty, calcareous material weathered from chalky shale and limestone. It is on strongly sloping side slopes and ridgetops. The areas of Rock outcrop are on the steep and very steep side slopes and ridgetops, on the steep side slopes of buttes, ridges, and escarpments, or on eroded side slopes along intermittent drainageways. Areas range from 20 to 300 acres in size. They consist of 30 to 50 percent Enning soil and

30 to 60 percent areas of Rock outcrop. These areas are so intermingled or mixed that separating them in mapping is not practical.

Typically, the surface layer of the Enning soil is light yellowish brown, friable, calcareous silty clay loam about 3 inches thick. The underlying material is brownish yellow, firm, calcareous silty clay loam to a depth of 18 inches. Below this to a depth of more than 60 inches is white, chalky shale.

Typically, the areas of Rock outcrop consist of eroded exposures of interbedded chalk and shale. In some places silt loam or silty clay loam that is less than 10 inches thick is on the chalk and shale.

Included with this unit in mapping are small areas of Manvel and Minnequa soils. Manvel soils are very deep and are on foot slopes and alluvial fans. Minnequa soils are moderately deep over interbedded chalk and shale and are on the lower slopes. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Enning soil, and available water capacity is very low. The organic matter content is moderately low. Runoff is very rapid.

All of the acreage in this map unit is used as range. It is not suited to cropland because of the rugged terrain, the shallow soils, and the areas of shale outcrop.

If this map unit is used as range, the climax vegetation on the Enning soil is dominantly little bluestem, sideoats grama, blue grama, and threadleaf sedge. These species make up 70 percent or more of the total annual forage. Prairie sandreed, western wheatgrass, hairy grama, sand bluestem, big bluestem, needleandthread, green needlegrass, and forbs make up the rest. If subject to continuous heavy grazing, little bluestem, sand bluestem, and big bluestem decrease in abundance and are replaced by sideoats grama, blue grama, hairy grama, prairie sandreed, sand dropseed, threadleaf sedge, and forbs. If overgrazing continues for many years, woody plants may invade the site.

If the range is in excellent condition, the suggested initial stocking rate on the Enning soil is 0.5 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. The slope can hinder the movement of livestock. Brush management may be needed in some areas to control the woody plants that invade the site.

The Enning soil is generally not suited to the trees and shrubs planted in windbreaks. A few areas can be used for the trees and shrubs that enhance

recreational areas or wildlife habitat if they are planted by hand or if other special management is used.

The Enning soil is not suited to septic tank absorption fields because of the steep slope, the shallow depth to bedrock, and the areas of shale outcrop. The excessive slope generally is too severe a limitation to overcome for building site development. Cutting and filling are needed to provide a suitable grade for roads.

The land capability unit is VIIIs-4, dryland, for the Enning soil and VIIIs-8, dryland, for the areas of Rock outcrop. The Enning soil is in the Shallow Limy range site. No range site is assigned to the areas of Rock outcrop. The Enning soil and the areas of Rock outcrop are in windbreak suitability group 10.

**EwG—Epping-Badland complex, 3 to 60 percent slopes.** This map unit consists of the shallow, gently sloping to very steep, well drained Epping soil and areas of Badland. The Epping soil formed in material weathered from siltstone. Badland is the eroded, barren exposures of siltstone and shale that support little or no vegetation. The Epping soil is on ridgetops and side slopes. Badland is along the deeply dissected drainageways and gullies that form at close intervals. Areas range from 20 to 400 acres in size. They consist of 40 to 65 percent Epping soil and 25 to 50 percent Badland. These areas are so intermingled or mixed that separating them in mapping is not practical.

Typically, the Epping soil has a surface layer of pale brown, very friable, calcareous very fine sandy loam about 4 inches thick. The transitional layer is pale brown, very friable, calcareous very fine sandy loam about 4 inches thick. The underlying material is very pale brown, very friable, calcareous very fine sandy loam to a depth of 15 inches. Below this to a depth of more than 60 inches is very pale brown, calcareous siltstone. In some areas siltstone is within a depth of 10 inches. In some areas lime is below a depth of 6 inches. In some places the surface layer is silt loam or loam.

Badland is the eroded, nearly barren exposures of siltstone and shale.

Included with this unit in mapping are small areas of Thirtynine and Mitchell soils. Thirtynine soils have more clay in the subsoil than the Epping soil and siltstone below a depth of 40 inches. They are lower on the landscape than the Epping soil and the Badland. Mitchell soils are very deep and are on foot slopes below areas of the Epping soil and the Badland. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Epping soil, and available water capacity is very low. The organic matter content is low. Runoff is medium and rapid on the Epping soil and very rapid in areas of the Badland.

All of the acreage in this map unit is used for range. It is not suited to cultivation because of the rugged terrain, the shallow soils, and the areas of rock outcrop.

If this map unit is used as range, the climax vegetation on the Epping soil is dominantly little bluestem, sideoats grama, western wheatgrass, blue grama, and threadleaf sedge. The species make up 60 percent or more of the total annual forage. Prairie sandreed, hairy grama, sand bluestem, big bluestem, needleandthread, green needlegrass, and forbs make up the rest. If subject to continuous heavy grazing, little bluestem, sand bluestem, and big bluestem decrease in abundance and are replaced by sideoats grama, blue grama, hairy grama, prairie sandreed, sand dropseed, threadleaf sedge, and forbs. If overgrazing continues for many years, woody plants may invade the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.5 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. The slope can hinder the movement of livestock. Brush management may be needed in some areas to control the woody plants that invade the site.

The Epping soil generally is not suited to the trees and shrubs planted in windbreaks. The very steep and shallow soils severely limit the planting, survival, and growth of trees and shrubs. Onsite investigation may identify small areas that are suitable for planting the trees and shrubs that enhance recreational areas or wildlife habitat if they are planted by hand or if other special management is used.

The Epping soil is not suited to septic tank absorption fields because of the shallow depth to bedrock and the steep slope. A suitable alternative site should be selected. The excessive slope generally is too severe a limitation to overcome for building site development. Cutting and filling are needed to provide a suitable grade for roads.

The land capability unit is VIIs-4, dryland, for the Epping soil and VIIs-8, dryland, for the Badland. The Epping soil is in the Shallow Limy range site. No range site is assigned to the Badland. The Epping soil and the Badland are both in windbreak suitability group 10.

#### **Fu—Fluvaquents, sandy, 0 to 1 percent slopes.**

This very deep, nearly level, very poorly drained soil is on bottom land. It formed in sandy alluvium. This soil is in oxbows and the low lying areas bordering the larger streams. It is subject to frequent flooding for brief to very long periods from stream overflow and is ponded for long periods by a very high water table. Individual areas range from 5 to 20 acres in size.

Typically, the surface layer is dark grayish brown loamy sand about 3 inches thick. The underlying material to a depth of more than 60 inches is light gray fine sand and sand stratified with lighter and darker strata of loamy sand to loam. In some places a layer of decaying leaves and stems is on the surface. In other places the surface layer is loam.

Included with this soil in mapping are small areas of Almeria, Bolent, and Las Animas soils. The included soils are better drained than the Fluvaquents and are slightly higher on the landscape. Also included are small areas of water in low areas and in former stream channels and oxbows. Included areas make up 5 to 15 percent of the unit.

Permeability is rapid in the Fluvaquents. Available water capacity is low. Organic matter content is moderate or high. Runoff is very slow to ponded. The seasonal high water table ranges from 2 feet above the surface during wet years to about 1 foot below the surface during dry years. This soil has water above the surface for long periods during most years. During extended dry periods the water table normally recedes below the surface.

This soil is used mainly as wildlife habitat. Areas of this soil are too wet for cultivated cropland, hayland, or range. The vegetation is coarse and nonpalatable for livestock. Vegetation consists mainly of cattails, rushes, arrowheads, willows, and other water tolerant plants.

This soil is not suitable for the trees and shrubs planted in windbreaks because of the wetness. A few marginal areas may be suitable for the trees or shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used.

This soil is not suited to use as septic tank absorption fields and building sites because of the frequent flooding. A suitable alternative site should be selected. The excavations should be made only during extremely dry periods. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Constructing roads on suitable, well compacted fill material above the flood level, providing adequate side ditches, and installing culverts help protect roads from the damage caused by

flooding and the wetness caused by the seasonal high water table.

The land capability unit is VIIIw-7, dryland, and windbreak suitability group 10. No range site is assigned.

**Gg—Gannett loam, 0 to 1 percent slopes.** This very deep, nearly level, poorly drained soil is in sandhill valleys. It formed in loamy and sandy alluvium. This soil is subject to rare flooding. Individual areas range from 20 to 100 acres in size.

Typically, the surface layer is dark gray, friable loam about 16 inches thick. The subsurface layer is very dark gray, friable loam about 7 inches thick. The underlying material is light gray, mottled fine sand to a depth of more than 60 inches. In places the underlying material has strata of fine sandy loam and loamy fine sand. In some areas the surface layer is fine sandy loam or sandy loam. In some places this soil is very poorly drained.

Included with this soil in mapping are small areas of Els, calcareous; Elsmere; Ipage; Marlake; and Tryon soils. The included soils have more sand in the upper part of the profile than the Gannett soil. Els, calcareous; Elsmere; and Ipage soils are higher on the landscape than the Gannett soil. Marlake soils are lower on the landscape than the Gannett soil and have water above the surface for most of the growing season. Tryon soils are on similar landscapes as the Gannett soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the solum in the Gannett soil and rapid in the underlying material. Available water capacity is moderate. The organic matter content is high. Runoff is very slow. The seasonal high water table ranges from the surface during wet years to a depth of 1.5 feet during dry years.

All of the acreage of this soil is used as range or hayland. It is too wet for use as cropland.

If this soil is used as range or hayland, the climax vegetation is dominantly big bluestem, indiangrass, prairie cordgrass, and switchgrass. These species make up 65 percent or more of the total annual forage. Bluegrass, slender wheatgrass, sedges, rushes, and forbs make up the rest. If subject to continuous heavy grazing or improperly harvested for hay, big bluestem, prairie cordgrass, switchgrass, and indiangrass decrease in abundance and are replaced by slender wheatgrass, western wheatgrass, plains muhly, and sedges. If overgrazing or improper haying continues for many years, bluegrass, western wheatgrass, sedges, rushes, and forbs dominate the site.

If the range is in excellent condition the suggested initial stocking rate is 1.8 animal unit months per acre. A planned grazing system that includes proper grazing use, timely deferments from grazing and haying, and restricted use during very wet periods helps to maintain and improve the range condition. Areas of this soil are generally the first to be overgrazed in a pasture that includes the better drained, sandy soils. Properly located fences and livestock watering and salting facilities result in a more uniform distribution of grazing. During wet periods, grazing and operating heavy machinery cause surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. Large meadows can be divided into three sections and the sections mowed in rotation. The order in which the sections are mowed should be changed in successive years. After the ground is frozen, livestock can graze without damaging the meadows. They should be removed in the spring before the ground thaws and the water table reaches a high level.

This soil is suited to the trees and shrubs planted in windbreaks. The main limitation affecting the establishment of windbreaks is the wetness caused by the high water table. The species selected for planting should be those that withstand the occasional wetness. Tilling and planting seedlings should be delayed until after the soil has begun to dry. The weeds and undesirable grasses can be controlled by cultivation between the tree rows with conventional equipment and by the use of the appropriate kind of herbicide in the tree rows.

This soil is not suited to septic tank absorption fields and building sites because of the wetness and the flooding. A suitable alternative site should be selected. The sides of shallow excavations can cave in unless they are shored. The excavations should be made during dry periods. Constructing roads on suitable, well compacted fill material above the flood level, providing adequate side ditches, and installing culverts help protect roads from the damage caused by flooding and the wetness. A good surface drainage system and a gravel moisture barrier in the subgrade can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

The land capability unit is Vw-7, dryland; Wet Subirrigated range site; and windbreak suitability group 2D.

**Gh—Gannett loam, wet, 0 to 1 percent slopes.**

This very deep, nearly level, very poorly drained soil is in sandhill valleys. It formed in loamy and sandy alluvium. It is occasionally ponded by water from the seasonal high water table. This soil is subject to rare flooding. Areas range from 20 to 50 acres.

Typically, the surface layer is dark gray, very friable loam about 19 inches thick. The subsurface layer is gray, friable loam about 10 inches thick. The underlying material is light gray, mottled fine sand to a depth of 60 inches or more. In some areas the surface layer is fine sandy loam. In places the underlying material has strata of fine sandy loam and loamy fine sand. In a few areas this soil is poorly drained.

Included with this soil in mapping are small areas of Els, Elsmere, lpage, Marlake, and Tryon soils. The included soils have more sand in the profile than the Gannett soil. Els, Elsmere, and lpage soils are better drained than the Gannett soil and are higher on the landscape. Marlake and Tryon soils are very poorly drained and are lower on the landscape than the Gannett soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the solum in the Gannett soil and rapid in the underlying material. Available water capacity is moderate. The organic matter content is high. Runoff is very slow or ponded. The seasonal high water table ranges from about 0.5 foot above the surface during wet years to a depth of about 1.0 foot during dry years.

All of the acreage of this soil is used as range or hayland. This soil is not suitable for farming.

If this soil is used as range or hayland, the climax vegetation is dominantly prairie cordgrass, bluejoint reedgrass, and northern reedgrass. These species make up 55 percent or more of the total annual production. Bluegrass, slender wheatgrass, green muhly, and forbs make up the rest. If subject to continuous heavy grazing or improperly harvested for hay, prairie cordgrass, bluejoint reedgrass, and northern reedgrass decrease in abundance and are replaced by slender wheatgrass, bluegrass, green muhly, sedges, rushes, and forbs. If overgrazing or improper haying continues for many years, bluegrass, foxtail barley, sedges, rushes, and forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 2.0 animal unit months per acre. This soil produces a high quantity of low-quality forage. A planned grazing system that includes proper grazing use, timely deferments from grazing and haying, and restricted use during wet periods helps to maintain or improve the range condition. During wet periods, grazing and operating heavy machinery can

cause surface compaction and the formation of mounds and ruts, which make grazing or harvesting hay difficult.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. In wet years, some areas of hay cannot be harvested. After the ground is frozen, livestock can graze without damaging the meadows. They should be removed in the spring before the ground thaws.

This soil is not suited to the trees and shrubs planted in windbreaks because of the wetness caused by the high water table. A few marginal areas may be suitable for the trees or shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used.

This soil is not suited to septic tank absorption fields or building sites because of the wetness caused by the seasonal high water table and the hazard of flooding. A suitable alternative site should be selected. The sides of shallow excavations can cave in unless they are shored. The excavations should be made during dry periods. Constructing roads on suitable, well compacted fill material above the level of ponding, providing adequate side ditches, and installing culverts help protect roads from the damage caused by ponding and the wetness caused by the seasonal high water table and the rare flooding. A good surface drainage system and a gravel moisture barrier in the subgrade can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

The land capability unit is Vw-7, dryland; Wetland range site; and windbreak suitability group 10.

**Hm—Hoffland fine sandy loam, 0 to 1 percent slopes.** This very deep, nearly level, poorly drained soil is in sandhill valleys. It formed in sandy alluvium. This soil is subject to rare flooding. Areas range from 20 to 100 acres.

Typically, the surface layer is gray, friable, calcareous fine sandy loam about 4 inches thick. The subsurface layer is friable, calcareous fine sandy loam about 7 inches thick. It is grayish brown in the upper part and gray in the lower part. The underlying material is mottled, light gray fine sand to a depth of more than 60 inches. In some places the surface layer is loam. In places the underlying material is calcareous. In a few places the soil is very poorly drained. In some areas the solum is more than 20 inches thick.

Included with this soil in mapping are small areas of Els, lpage, and Wildhorse soils. The included soils are better drained than the Hoffland soil and are higher on

the landscape. Wildhorse soils have a high content of sodium. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Hoffland soil, and available water capacity is low. The organic matter content is very high. Runoff is very slow. The soil has a seasonal high water table that ranges from the surface during wet years to a depth of 1.5 feet during dry years.

Nearly all of the acreage of this soil is used as range. Most of the grasses are mowed for hay, but a few areas are grazed. This soil is not suitable for farming because of the wetness caused by the seasonal high water table.

If this soil is used as range or hayland, the climax vegetation is dominantly big bluestem, indiangrass, prairie cordgrass, and switchgrass. These species make up 60 percent or more of the total annual forage. Bluegrass, slender wheatgrass, sedges, rushes, and forbs make up the rest. If subject to continuous heavy grazing or improperly harvested for hay, big bluestem, prairie cordgrass, switchgrass, and indiangrass decrease in abundance and are replaced by slender wheatgrass, western wheatgrass, plains muhly, and sedges. If overgrazing or improper haying continues for many years, bluegrass, western wheatgrass, sedges, rushes, and forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 1.8 animal unit months per acre. A planned grazing system that includes proper grazing use, timely deferments from grazing and haying, and restricted use during wet periods helps to maintain or improve the range condition. Areas of this soil are generally the first to be overgrazed in a pasture that includes the better drained, sandy soils. Properly located fences and livestock watering and salting facilities result in a more uniform distribution of grazing. During wet periods, grazing and operating heavy machinery cause surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. Large meadows can be divided into three sections and the sections mowed in rotation. The order in which the sections are mowed should be changed in successive years. After the ground is frozen, livestock can graze without damaging the meadows. They should be removed in the spring before the ground thaws and the water table reaches a high level.

This soil is suited to the trees and shrubs planted in windbreaks. The primary limitation affecting the establishment of windbreaks is the wetness caused by the high water table. The species selected for planting

should be those that can withstand the occasional wetness. Tilling and planting seedlings should be delayed until after the soil has begun to dry. The weeds and undesirable grasses can be controlled by cultivation between the tree rows with conventional equipment and by the use of the appropriate kind of herbicide in the tree rows.

This soil is generally not suited to septic tank absorption fields because of the wetness caused by the seasonal high water table and the flooding. A suitable alternative site should be selected. This soil is not suited to building sites because of the flooding and the wetness. A suitable alternative site should be selected. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving if the excavations are made during dry periods. Constructing roads on suitable, well compacted fill material, providing adequate side ditches, and installing culverts help protect roads from the wetness and the damage caused by flooding.

The land capability unit is Vw-7, dryland; Wet Subirrigated range site; and windbreak suitability group 2D.

**Hn—Hoffland fine sandy loam, wet, 0 to 1 percent slopes.** This very deep, nearly level, very poorly drained soil is in sandhill valleys. It formed in sandy alluvium. This soil is occasionally ponded by water from the seasonal high water table. This soil is subject to rare flooding. Areas range from 30 to 50 acres in size.

Typically, the surface layer is gray, friable, calcareous fine sandy loam about 8 inches thick. The transitional layer is light gray, mottled, friable, calcareous fine sandy loam 6 inches thick. The underlying material is light gray and grayish brown, mottled, calcareous fine sand and loamy fine sand to a depth of about 27 inches. Below this to a depth of 60 inches is light gray fine sand. In some areas the surface layer is less than 6 inches thick. In a few places the loamy material is more than 2 feet thick over the sandy material. In some areas the surface layer is loam. In some places the underlying material is stratified with thin layers of loam and fine sandy loam.

Included with this soil in mapping are small areas of Els, Wildhorse, and Marlake soils. Els and Wildhorse soils are better drained than the Hoffland soil and are higher on the landscape. Wildhorse soils have a high content of sodium. Marlake soils are lower on the landscape than the Hoffland soil and have water above the surface for most of the growing season. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Hoffland soil. Available

water capacity is low. The organic matter content is very high. Runoff is very slow or ponded. The seasonal high water table ranges from about 0.5 foot above the surface during wet years to a depth of about 1.0 foot during dry years. It generally recedes to a depth of 2 feet or more in late summer.

All of the acreage of this soil is used as range. Most of the grasses are mowed for hay, but a few areas are grazed. This soil is not suited to farming because of the wetness caused by the seasonal high water table.

If this soil is used as range, either for grazing or hay, the climax vegetation is dominantly prairie cordgrass, northern reedgrass, bluejoint reedgrass, slender wheatgrass, and various sedges. These species make up 75 percent or more of the total annual forage. Rushes and other perennial grasses and forbs make up the rest. If subject to continuous heavy grazing or improperly harvested for hay, prairie cordgrass, bluejoint reedgrass, and northern reedgrass decrease in abundance. Initially, these species are replaced by slender wheatgrass, plains bluegrass, green muhly, and various sedges, rushes, and forbs. If overgrazing or improper haying continues for many years, plains bluegrass, foxtail barley, and various sedges, rushes, and forbs dominate the site. During wet periods, continuous heavy grazing or operating heavy machinery causes surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult.

If the range is in excellent condition, the suggested initial stocking rate is 2.0 animal unit months per acre. This soil produces high yields, but the forage is of low quality. The forage is of higher quality early in the growing season. A planned grazing system that includes proper grazing use, timely deferments from grazing and haying, and restricted use during very wet periods helps to maintain or improve the range condition.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. In some years hay cannot be harvested because of the excessive wetness. Large meadows can be divided into three sections and mowed in rotation. The order in which the sections are mowed should be changed in successive years. After the ground is frozen, livestock can graze without damaging the meadows. They should be removed in the spring before the ground thaws and the water table reaches a high level.

This soil is not suited to the trees or shrubs planted in windbreaks because of the wetness caused by the seasonal high water table. A few marginal areas may be suitable for the trees or shrubs that enhance recreational areas and wildlife habitat and for

forestation if the tolerant species are planted by hand or if other special management is used.

This soil is not suited to sanitary facilities or building sites because of the wetness caused by the seasonal high water table and the hazard of flooding. A suitable alternative site should be selected. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving if the excavations are made during dry periods. Constructing roads on suitable, well compacted fill material above the level of ponding, providing adequate side ditches, and installing culverts help protect roads from the wetness and the damage caused by ponding.

The land capability unit is Vw-7, dryland; Wetland range site; and windbreak suitability group 10.

**IpB—lpage fine sand, 0 to 3 percent slopes.** This very deep, nearly level and very gently sloping, moderately well drained soil is in sandhill valleys. It formed in eolian sand. Individual areas range from 10 to about 200 acres in size.

Typically, the surface layer is dark grayish brown, loose fine sand about 5 inches thick. The transitional layer is grayish brown, loose fine sand about 6 inches thick. The underlying material is light brownish gray and pale brown fine sand to a depth of more than 60 inches. The lower part is mottled. In some areas the dark surface soil is more than 10 inches thick. In some places the surface layer is sand, loamy fine sand, or loamy sand. In other places carbonates are at a depth of less than 20 inches.

Included with this soil in mapping are small areas of Els, calcareous; Hoffland; Valent; Valentine; and Wildhorse soils. Els, calcareous, and Wildhorse soils are lower on the landscape than the lpage soil and are somewhat poorly drained. Also, Wildhorse soils have a high content of sodium. Hoffland soils are poorly drained and are lower on the landscape than the lpage soil. Valent and Valentine soils are excessively drained and are on dunes. Included soils make up 10 to 15 percent of the unit.

Permeability is rapid in the lpage soil, and available water capacity is low. The organic matter content is low. Runoff is slow. This soil has a seasonal high water table that ranges from a depth of 3 feet during wet years to 5 feet during dry years. The water intake rate is very high.

Most of the acreage of this soil is used as range. A few small areas are used for irrigated crops.

This soil is not suited to dryland crops because of droughtiness and the hazard of soil blowing.

If irrigated by a sprinkler system, this soil is poorly suited to corn, alfalfa, and introduced grasses. This

soil is too sandy for gravity irrigation. Soil blowing is a hazard if the surface is unprotected. Stripcropping, stubble mulching, and cover crops help to control soil blowing and conserve soil moisture. This soil is droughty because of the low available water capacity, and light, frequent applications of irrigation water are needed. Excessive amounts of water can leach essential plant nutrients below the root zone. Returning crop residue, green manure crops, and feedlot manure to the soil helps improve the organic matter content and fertility.

If this soil is used as range or hayland, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, switchgrass, and needleandthread. These species make up 75 percent or more of the total annual forage. Blue grama, prairie junegrass, bluegrass, indiagrass, sedges, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, indiagrass, little bluestem, and switchgrass decrease in abundance and are replaced by prairie sandreed, needleandthread, sand dropseed, blue grama, sedges, and forbs. If overgrazing continues for many years, blue grama, sand dropseed, needleandthread, Scribner panicum, sedges, and forbs dominate the site. Under these conditions, the native plants lose vigor and are unable to stabilize the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, mowing should be regulated so that the grasses remain healthy and vigorous. The forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range.

This soil is suited to the trees and shrubs planted in windbreaks. Soil blowing is a severe hazard affecting the establishment of windbreaks. It can be controlled by planting the seedlings in shallow furrows with as little disturbance of the soil as possible. Maintaining strips of sod or cover crops between the tree rows also helps to control soil blowing. Insufficient rainfall in summer is also a hazard affecting the survival of young trees. Irrigation can provide supplemental moisture during periods of low rainfall. The weeds and undesirable grasses in the tree rows can be controlled

by careful use of the appropriate kind of herbicide or by hoeing by hand.

Constructing septic tank absorption fields on fill material raises the fields a sufficient distance above the seasonal high water table. Seepage from the septic tank can result in pollution of the ground water. This soil is generally suited to sites for dwellings and buildings without basements. Buildings with basements should be constructed on raised, well compacted fill material to overcome the wetness caused by the high water table. A good surface drainage system and a gravel moisture barrier in the subgrade can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

The land capability units are VIe-5, dryland, and IVe-12, irrigated; Sandy Lowland range site; and windbreak suitability group 7.

**JgB—Jayem fine sandy loam, 0 to 3 percent slopes.** This very deep, nearly level and very gently sloping, well drained soil is on uplands. It formed in loamy and sandy eolian material weathered from sandstone. Areas range from 5 to 600 acres in size.

Typically, the surface layer is grayish brown, very friable fine sandy loam about 8 inches thick. The subsurface layer is about 8 inches thick. It is similar to the surface layer in color and texture. The subsoil is light brownish gray and light gray, very friable fine sandy loam about 16 inches thick. The underlying material is light gray very fine sandy loam and loamy very fine sand to a depth of more than 60 inches. In some places carbonates are within a depth of 40 inches. In places the dark surface layer is more than 20 inches thick. In some places the surface layer is loamy fine sand.

Included with this soil in mapping are small areas of Dailey, Satanta, and Tuthill soils. Dailey soils have more sand throughout the profile than the Jayem soil and are on similar landscapes. Satanta and Tuthill soils have more clay in the subsoil than the Jayem soil and are on similar landscapes. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Jayem soil, and available water capacity is moderate. The organic matter content is moderately low. Runoff is slow. The water intake rate is moderately high.

Most of the acreage of this soil is used as dryland or irrigated cropland. Some areas are used for range.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in

summer generally limits the cultivated crops that can be successfully grown. Soil blowing is the principal hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to control soil blowing. Because of the moderate available water capacity, these tillage practices also help to conserve soil moisture. Cover crops also help to control erosion. Returning crop residue to the soil helps improve the organic matter content and the water intake rate.

If irrigated, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. This soil is best suited to sprinkler irrigation because of the moderately high water intake rate. Some land leveling is generally needed if gravity systems are used so that the movement and intake rate of water are uniform. Soil blowing is the principal hazard. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue and green manure crops into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with other crops. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or trefoil, or warm-season grasses, such as switchgrass or big bluestem, into pasture and hayland. Continuous heavy grazing reduces the amount of protective cover and the quality of the stands, resulting in a severe hazard of soil blowing. Managing separate pastures of cool- and warm-season grasses can extend the grazing season. Rotation grazing and proper stocking rates help keep the grasses in good condition. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be applied by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil blowing. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. As a result, soil blowing is excessive and small blowouts can form. Proper grazing use, timely deferments from grazing or haying, and a planned

grazing system help to maintain or improve the condition of the native plants.

This soil is suited to the trees and shrubs planted in windbreaks. Soil blowing is the main hazard affecting the establishment of windbreaks. It can be controlled by maintaining strips of sod or a cover crop between the tree rows. The weeds and undesirable grasses in the tree rows can be controlled by careful use of the appropriate kind of herbicide or by hoeing by hand. Cultivation between the tree rows with conventional equipment can control undesirable grasses and weeds in areas where strips of sod and cover crops are not used. The lack of adequate rainfall in summer is also a hazard affecting the survival of young trees. Irrigation can provide supplemental moisture during periods of low rainfall.

This soil is generally suitable for septic tank absorption fields, building sites, and roads. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

The land capability units are 111e-3, dryland, and 11e-8, irrigated; Sandy range site; and windbreak suitability group 5.

**JgC—Jayem fine sandy loam, 3 to 6 percent slopes.** This very deep, gently sloping, well drained soil is on side slopes on uplands. It formed in loamy and sandy eolian material weathered from sandstone. Areas range from 5 to 240 acres in size.

Typically, the surface layer is grayish brown, very friable fine sandy loam about 7 inches thick. The subsurface layer is grayish brown, very friable fine sandy loam about 4 inches thick. The subsoil is light brownish gray, very friable fine sandy loam about 13 inches thick. The underlying material is light gray fine sandy loam to a depth of more than 60 inches. In some places the dark surface layer is more than 20 inches thick. In other places the dark surface layer is less than 7 inches thick. In some areas the underlying material is loamy fine sand and is within a depth of 40 inches. In some cultivated areas the surface layer is loamy fine sand. In places the underlying material is calcareous within a depth of 40 inches.

Included with this soil in mapping are small areas of Dailey, Satanta, and Tuthill soils. Dailey soils have more sand throughout the profile than the Jayem soil and are slightly higher on the landscape. Satanta and Tuthill soils have more clay in the subsoil than the Jayem soil and are on similar landscapes. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Jayem soil, and available water capacity is moderate. The organic matter content is moderately low. Runoff is slow and

medium. The water intake rate is moderately high. The surface layer is very friable and is easily tilled throughout a wide range in moisture content.

About half of the acreage of this soil is used as cropland. Some areas are irrigated. The rest is used for range.

If dryland farmed, this soil is poorly suited to small grains, alfalfa, and introduced grasses. Inadequate rainfall in summer generally limits the cultivated crops that can be grown. Water erosion and soil blowing are the principal hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to control soil blowing and water erosion. Because of the moderate available water capacity, these tillage practices also help to conserve soil moisture. Stripcropping, terraces, and annual cover crops help to control soil blowing and water erosion. Summer fallowing conserves moisture for use during the following growing season.

If irrigated, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. This soil is best suited to sprinkler irrigation because of the slope and the moderately high water intake rate. Extensive land leveling is needed if gravity systems are used. Soil blowing and water erosion are the principal hazards. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue and green manure crops into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients and result in the hazard of water erosion on the slopes.

This soil is poorly suited to introduced grasses used as pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. This soil is subject to water erosion. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Continuous heavy grazing and improper haying also reduce the amount of protective cover and can result in soil blowing and the formation of small gullies and rills after heavy rains. Managing separate pastures of cool- and warm-

season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil blowing and water erosion. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. As a result, soil blowing is excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs planted in windbreaks. Soil blowing and water erosion are the main hazards affecting the establishment of windbreaks. Erosion can be controlled by maintaining strips of sod or a cover crop between the tree rows. Planting on the contour helps to control water erosion. The weeds and undesirable grasses in the tree rows can be controlled by careful use of the appropriate kind of herbicide or by hoeing by hand. Cultivation between the rows with conventional equipment can control undesirable grasses and weeds in areas where strips of sod and cover crops are not used. The lack of adequate rainfall in summer is also a hazard affecting the survival of young trees. Irrigation can provide supplemental moisture during periods of low rainfall.

This soil is generally suitable for septic tank absorption fields and roads. The sides of shallow excavations can cave unless they are shored. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient.

The land capability units are IVe-3, dryland, and IIle-8, irrigated; Sandy range site; and windbreak suitability group 5.

**JgD—Jayem fine sandy loam, 6 to 9 percent slopes.** This very deep, strongly sloping, well drained soil is on uplands. It formed in loamy and sandy eolian material weathered from sandstone. Individual areas range from 5 to 240 acres in size.

Typically, the surface layer is grayish brown, very friable fine sandy loam about 8 inches thick. The subsurface layer is about 5 inches thick. It is similar to the surface layer in color and texture. The subsoil is brown, very friable fine sandy loam about 8 inches thick. The underlying material to a depth of more than

60 inches is grayish brown fine sandy loam in the upper part and light brownish gray loamy fine sand in the lower part. In some cultivated areas the surface layer is loamy fine sand. In places the underlying material is calcareous within a depth of 40 inches.

Included with this soil in mapping are small areas of Busher, Dailey, and Satanta soils. Busher and Dailey soils are on similar landscapes as the Jayem soil. Busher soils have weakly cemented, limy sandstone at a depth of 40 to 60 inches. Dailey soils have more sand throughout the profile. Satanta soils have more clay in the subsoil than the Jayem soil and are lower on the landscape. Included soils make up 10 to 15 percent of the unit.

Permeability is moderately rapid in the Jayem soil, and available water capacity is moderate. The organic matter content is moderately low. Runoff is medium. The water intake rate is moderately high.

Most of the acreage of this soil is used as range. Some areas are cultivated.

If dryland farmed, this soil is poorly suited to small grains, alfalfa, and introduced grasses. Inadequate rainfall in summer generally limits the crops that can be successfully grown. Soil blowing and water erosion are hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and stripcropping, helps to control soil blowing and water erosion and conserve soil moisture. Because of the moderate available water capacity, these tillage practices also help to conserve the available soil moisture. Incorporating crop residue and manure into the soil helps improve the organic matter content and fertility.

If irrigated by a sprinkler system, this soil is poorly suited to corn, small grains, alfalfa, and introduced grasses. This soil is not suited to gravity irrigation systems because of the slope. Soil blowing and water erosion are hazards in areas where the surface is not protected by crops or crop residue. A system of conservation tillage, such as no-till, keeps crop residue on the surface, helps to control erosion, and conserves soil moisture. Cover crops also help to control erosion. Returning crop residue, green manure crops, and manure to the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can result in the hazard of water erosion on the slopes and leach plant nutrients below the root zone.

If this soil is used for range or native hay, the climax vegetation is dominantly prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 65 percent or more of the total

annual forage. Blue grama, switchgrass, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, prairie sandreed, blue grama, Scribner panicum, sand dropseed, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

This soil is suited to the trees and shrubs planted in windbreaks. Soil blowing and water erosion are the main hazards affecting the establishment of windbreaks. Erosion can be controlled by maintaining strips of sod or cover crops between the tree rows. Planting trees on the contour helps to control water erosion. Irrigation can provide supplemental moisture during periods of low rainfall. The weeds and undesirable grasses in the tree rows can be controlled by careful use of the appropriate kind of herbicide or by hoeing by hand.

This soil is generally suited to septic tank absorption fields and sites for roads and streets. Dwellings and buildings should be properly designed so that they conform to the natural slope of the land, or the soil can be graded to an acceptable gradient. The sides of shallow excavations can cave in unless they are shored.

The land capability units are IVe-3, dryland, and IVe-8, irrigated; Sandy range site; and windbreak suitability group 5.

**Jo—Johnstown loam, 0 to 1 percent slopes.** This very deep, nearly level, well drained soil is on uplands. It formed in loess and loamy sediment deposited over gravelly sand. Areas range from 5 to 320 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 7 inches thick. The subsurface layer is dark grayish brown, friable loam about 4 inches thick. The subsoil is about 26 inches thick. The upper part is grayish brown, firm silty clay loam over a buried soil that is dark grayish brown, firm silty clay loam in the upper part and pale brown, firm silty clay loam in the lower part. The lower part of the subsoil is light

gray, friable, calcareous loam. The underlying material to a depth of more than 60 inches is light gray, calcareous loam in the upper part and light gray, calcareous gravelly coarse sand in the lower part. In some places the surface layer is silt loam, fine sandy loam, or clay loam. In some areas the dark surface soil is less than 20 inches thick. In some places the gravelly layer is at a depth of more than 60 inches. In places the gravelly layer is within a depth of 40 inches because of land leveling.

Included with this soil in mapping are small areas of Bridget soils, which are calcareous and contain less clay in the profile than the Johnstown soil. These soils are on similar landscapes. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the solum in the Johnstown soil and rapid and very rapid in the underlying material. Available water capacity is moderate. The organic matter content is moderate. Runoff is slow. The water intake rate is moderately low.

Most of the acreage of this soil is used for irrigated crops. The rest is used mainly for dryland crops.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Soil blowing is a slight hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, help to conserve soil moisture and control soil blowing. Returning crop residue to the soil helps to maintain the organic matter content and improve the water intake rate.

If irrigated, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. It is suited to sprinkler and gravity irrigation systems (fig. 11). Some land leveling is needed if gravity systems are used so that the distribution of water is uniform. Soil blowing is a slight hazard. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue into the soil helps to maintain the organic matter content and fertility. Irrigation systems should be designed so that the water application rate does not exceed the moderately low water intake rate. A tailwater recovery system can be used to conserve water.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season

grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil blowing. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of native plants. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall is the principal hazard. Seedlings can survive and grow if competing vegetation is controlled or removed by cultivation or by the careful use of the appropriate kind of herbicide. Irrigation can provide supplemental moisture during periods of low rainfall.

This soil is generally suited to sites for dwellings and buildings with basements. Because of the rapid and very rapid permeability of the gravelly underlying material, this soil does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in pollution of the ground water. Mounding the site with several feet of suitable fill material improves the filtering capacity of the soil. The moderate permeability of the solum is also a limitation affecting septic tank absorption fields. Strengthening the foundations for dwellings and buildings without basements and backfilling with coarse textured material help to prevent the damage caused by the shrinking and swelling of the soil. Roads and streets need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained subgrade or base material can be used to ensure better performance.

The land capability units are Ilc-1, dryland, and I-4, irrigated; Silty range site; and windbreak suitability group 3.



Figure 11.—A gravity irrigation system in a field of dry, edible beans on Johnstown loam, 0 to 1 percent slopes.

**Kd—Kadoka silt loam, 0 to 2 percent slopes.**

This moderately deep, nearly level, well drained soil is on uplands. It formed in silty material weathered from siltstone. Areas range from 10 to 200 acres in size.

Typically, the surface layer is grayish brown, friable silt loam about 7 inches thick. The subsoil is about 13 inches thick. The upper part is grayish brown, friable silty clay loam, and the lower part is pale brown, friable calcareous loam. The underlying material is very pale brown, calcareous loam about 9 inches thick. Siltstone is below a depth of 29 inches. In some places siltstone is below a depth of 40 inches. In other places the surface layer is loam.

Included with this soil in mapping are small areas of Bridget, Epping, and Thirtynine soils. Bridget and Thirtynine soils do not have bedrock within a depth of 60 inches. Bridget soils also have less clay in the profile than the Kadoka soil and are on stream terraces and foot slopes. Thirtynine soils are very deep and are lower on the landscape than the Kadoka soil. Epping soils have siltstone within a depth of 20 inches and are on knolls and ridgetops. Included soils make up 10 to 15 percent of the unit.

Permeability and available water capacity are moderate in the Kadoka soil. Runoff is slow. The

organic matter content is moderate. The water intake rate is moderately low.

Most of the acreage of this soil is used for dryland farming. A few areas are irrigated. The rest is used mainly for range.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Soil blowing is a slight hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to conserve soil moisture. Cover crops also help to control erosion. Returning crop residue to the soil helps improve the organic matter content and the water intake rate.

If irrigated, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. It is suited to sprinkler and gravity irrigation systems. Some land leveling is generally needed if gravity systems are used so that the distribution of water is uniform. Soil blowing is a slight hazard. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to conserve soil moisture. Incorporating crop residue and

green manure crops into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water leach plant nutrients below the root zone.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with other crops as part of the crop rotation. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or trefoil, or warm-season grasses, such as switchgrass or big bluestem, on pasture and hayland. Continuous heavy grazing causes poor plant vigor. Managing separate pastures of cool- and warm-season grasses can extend the grazing season. Rotation grazing and proper stocking rates help to maintain or improve the condition of the grasses. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be applied by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil blowing. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs planted in windbreaks. The principal limitations are the restricted rooting depth and the moderate available water capacity. The lack of sufficient seasonal rainfall is a hazard. Irrigation can provide supplemental moisture during periods of low rainfall. The undesirable grasses and weeds can be controlled by cultivation with conventional equipment, rototilling, hoeing by hand, or the careful use of the appropriate kind of herbicide.

The use of this soil for septic tank absorption fields is limited by depth to bedrock. Mounding the site with several feet of suitable fill material improves the filtering capacity of the soil. This soil is generally suited to sites for dwellings without basements. The soft bedrock needs to be excavated for the construction of dwellings with basements or buildings that have deep foundations. Roads and streets need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance. Crowning the roads by

grading and constructing adequate side ditches help to provide the needed surface drainage.

The land capability units are IIc-1, dryland, and I-4, irrigated; Silty range site; and windbreak suitability group 6R.

**KdC—Kadoka silt loam, 2 to 6 percent slopes.**

This moderately deep, gently sloping, well drained soil is on upland side slopes. It formed in silty material weathered from siltstone. Areas range from 10 to 100 acres in size.

Typically, the surface layer is grayish brown, friable silt loam about 5 inches thick. The subsoil is about 15 inches thick. The upper part is grayish brown, friable silty clay loam, and the lower part is light brownish gray, friable, calcareous silt loam. The underlying material is white, friable, calcareous loam about 7 inches thick. Siltstone is below a depth of 27 inches. In some places the surface layer is loam. In cultivated areas 15 to 35 percent of this soil is eroded. In these areas erosion has removed all or most of the original surface soil, and tillage has mixed the remaining surface soil with the subsoil. In some places the surface layer is light in color and calcareous. In other places the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Bridget, Epping, and Thirtynine soils. Bridget and Thirtynine soils do not have bedrock within a depth of 60 inches. Bridget soils have less clay in the profile than the Kadoka soil and are on stream terraces and foot slopes. Epping soils have siltstone within a depth of 20 inches and are on knolls and ridgetops. Thirtynine soils are lower on the landscape than the Kadoka soil. Included soils make up 10 to 15 percent of the unit.

Permeability and available water capacity are moderate in the Kadoka soil. Runoff is medium. The organic matter content is moderate. The water intake rate is moderately low.

Most of the acreage of this soil is used for dryland farming. A few areas are irrigated. The rest is used mainly for range.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Water erosion and soil blowing are the principal hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to conserve soil moisture and control soil blowing and water erosion. Terracing and contour farming are also effective in

controlling erosion and conserving moisture. Returning crop residue to the soil helps improve the organic matter content and the water intake rate.

If irrigated, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. It is best suited to sprinkler irrigation systems because of the slope. Extensive land leveling is needed to prepare this soil for gravity irrigation systems. Water erosion and soil blowing are the principal hazards. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control erosion and conserve soil moisture. The use of cover crops during the winter also helps to control erosion. Incorporating crop residue and green manure crops into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water leach plant nutrients below the root zone and result in the hazard of water erosion on the slopes.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or trefoil, or warm-season grasses, such as switchgrass or big bluestem, on pasture or hayland. This soil is subject to water erosion. Continuous heavy grazing causes poor plant vigor and results in the formation of small gullies and rills after heavy rains. Managing separate pastures of cool- and warm-season grasses can extend the grazing season. Rotation grazing and proper stocking rates help to maintain or improve the condition of the grasses. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be applied by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil blowing. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants.

This soil is suited to the trees and shrubs planted in windbreaks. The principal limitations are the restricted rooting depth and the moderate available water capacity. Erosion and the lack of sufficient seasonal rainfall are the main hazards. Irrigation can provide supplemental moisture during periods of low rainfall. Cultivation between the tree rows with conventional

equipment helps to control weeds and grasses that compete with the trees for moisture. Competing vegetation in the tree rows needs to be controlled by rototilling, hoeing by hand, or the careful use of selected herbicides. Planting the trees on the contour helps to control water erosion.

The use of this soil for septic tank absorption fields is limited by depth to bedrock. Mounding the site with several feet of suitable fill material improves the filtering capacity of the soil. This soil is generally suited to sites for dwellings without basements. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. The soft bedrock needs to be excavated for the construction of dwellings with basements or buildings that have deep foundations. Roads and streets need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance. Crowning the roads by grading and constructing adequate side ditches help to provide the needed surface drainage.

The land capability units are 11le-1, dryland, and 11le-4, irrigated; Silty range site; and windbreak suitability group 6R.

#### **KdD—Kadoka silt loam, 6 to 9 percent slopes.**

This moderately deep, strongly sloping, well drained soil is on upland side slopes. It formed in silty material weathered from siltstone. Areas range from 10 to more than 100 acres in size.

Typically, the surface layer is grayish brown, friable silt loam about 7 inches thick. The subsoil is about 20 inches thick. The upper part is brown, friable silty clay loam, the middle part is pale brown, friable silt loam, and the lower part is very pale brown, friable, calcareous silt loam. The underlying material is very pale brown, calcareous silt loam to a depth of 32 inches. Below this is very pale brown siltstone. In some places the surface layer is loam. In cultivated areas 15 to 35 percent of this soil is eroded. In these areas erosion has removed all or most of the original surface soil, and tillage has mixed the remaining surface soil with the subsoil. In some places the surface layer is light in color and calcareous. In other places the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Bridget, Epping, and Thirtynine soils. Bridget soils have less clay in the profile than the Kadoka soil and do not have siltstone within a depth of 40 inches. These soils are on stream terraces and foot slopes. Epping soils have siltstone at a depth of 10 to 20 inches and are on ridges and shoulders of side slopes.

Thirtynine soils do not have siltstone within a depth of 60 inches and are lower on the landscape than the Kadoka soil. Included soils make up 10 to 15 percent of the unit.

Permeability and available water capacity are moderate in the Kadoka soil. Runoff is medium. The organic matter content is moderate. The water intake rate is moderately low.

Most of the acreage of this soil supports native grasses and is used as range. Some areas are used for cultivated crops.

If dryland farmed, this soil is poorly suited to small grains, alfalfa, and introduced grasses. Inadequate rainfall in summer generally limits crop selection. Erosion is a severe hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and stripcropping, helps to control water erosion and conserves soil moisture. Incorporating crop residue and manure into the soil helps improve the organic matter content and fertility.

If irrigated by a sprinkler system, this soil is poorly suited to corn, small grains, alfalfa, and introduced grasses. Water erosion is a severe hazard in unprotected areas. A system of conservation tillage, such as no-till, that keeps crop residue on the surface helps to control erosion and conserve soil moisture. Returning crop residue and green manure crops to the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can result in the hazard of water erosion on the slopes.

This soil is poorly suited to introduced grasses used as pasture and hayland. These grasses can be rotated with other crops. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or trefoil, or warm-season grasses, such as switchgrass or big bluestem, on pasture or hayland. This soil is subject to water erosion. Continuous heavy grazing causes poor plant vigor and results in the formation of small gullies and rills after heavy rains. Managing separate pastures of cool- and warm-season grasses can extend the grazing season. Rotation grazing and proper stocking rates help to maintain or improve the condition of the grasses. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be applied by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

If this soil is used for range or native hay, the climax vegetation is dominantly big bluestem, blue grama,

little bluestem, sideoats grama, and western wheatgrass. These species make up 65 percent or more of the total annual forage. Buffalograss, switchgrass, needleandthread, prairie junegrass, Scribner panicum, sedges, and forbs make up the rest. If subject to continuous heavy grazing, big bluestem, little bluestem, prairie junegrass, and switchgrass decrease in abundance and are replaced by blue grama, buffalograss, needleandthread, plains muhly, sand dropseed, tall dropseed, western wheatgrass, and forbs. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range. In areas where gullies have formed because of severe water erosion, land shaping or other mechanical practices may be needed to smooth and stabilize the site before it is reseeded.

This soil is suited to the trees and shrubs planted in windbreaks. The principal limitations are the restricted rooting depth and the moderate available water capacity. Water erosion and the lack of sufficient seasonal rainfall are the main hazards. Irrigation can provide supplemental moisture during periods of low rainfall. Competing vegetation needs to be controlled by cultivating between the tree rows with conventional equipment and by rototilling, hoeing by hand, or the careful use of the appropriate kind of herbicide in the tree rows.

The use of this soil for septic tank absorption fields is limited by depth to bedrock. Mounding the site with several feet of suitable fill material improves the filtering capacity of the soil. This soil is generally suited to sites for dwellings with basements or buildings that have deep foundations. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. Roads should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

The land capability units are IVe-1, dryland, and IVe-4, irrigated; Silty range site; and windbreak suitability group 6R.

**Ke—Keith loam, 0 to 1 percent slopes.** This very deep, nearly level, well drained soil is on uplands. It formed in loess. Areas range from 10 to 300 acres in size.

Typically, the surface layer is dark grayish brown, very friable loam about 6 inches thick. The subsurface layer is dark grayish brown, very friable loam about 5 inches thick. The subsoil is about 27 inches thick. The upper part is dark grayish brown and grayish brown, firm silty clay loam. The lower part is light gray, friable, calcareous silt loam. The underlying material to a depth of 60 inches or more is light gray, calcareous very fine sandy loam. In some areas calcareous sandstone is at a depth of 40 to 60 inches. In some places the dark surface soil is more than 20 inches thick. In some places the surface layer is silt loam.

Included with this soil in mapping are areas of Lodgepole and Satanta soils. Lodgepole soils are somewhat poorly drained and have more clay in the subsoil than the Keith soil. These soils are in upland depressions. Satanta soils have more sand in the subsoil than the Keith soil and are on similar landscapes. Included soils make up about 5 to 10 percent of the unit.

Permeability is moderate in the Keith soil, and available water capacity is high. Runoff is slow. The organic matter content is moderate. The water intake rate is moderately low.

Most of the acreage of this soil is farmed. About half of the cultivated areas are irrigated, and the rest is used for dryland farming. The remaining areas are used as range.

If dryland farmed, this soil is suited to small grains, alfalfa, and introduced grasses. The lack of adequate seasonal rainfall commonly limits the crops that can be successfully grown. Soil blowing is a slight hazard in areas where the surface is not protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to control soil blowing and conserve soil moisture. Returning crop residue and green manure crops to the soil helps to maintain the organic matter content and fertility. Stripcropping can help to control soil blowing. Summer fallowing conserves moisture for use during the following growing season.

If irrigated, this soil is suited to corn, sugar beets, field beans, small grains, alfalfa, and introduced grasses. It is suited to sprinkler and gravity irrigation systems. If gravity systems are used, some land leveling is needed to achieve uniform distribution of

irrigation water. Soil blowing is a slight hazard if the surface is unprotected. A system of conservation tillage, such as ecofallow or no-till, that keeps crop residue on the surface helps to control soil blowing. Returning crop residue and green manure crops to the soil helps to maintain the organic matter content and increases the water intake rate. Irrigation systems need to be designed so that the water application rate does not exceed the moderately low intake rate of this soil. A tailwater recovery system can be used to conserve water.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil blowing. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall is the principal hazard affecting seedlings and young trees. Competing vegetation between the tree rows can be controlled by cultivation with conventional equipment. The undesirable grasses or weeds in the rows can be controlled by rototilling, hoeing by hand, or the careful use of the appropriate kind of herbicide. Irrigation can provide supplemental moisture during periods of low rainfall.

This soil is generally suited to sites for dwellings and buildings with basements. The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption

field can generally overcome this limitation. Roads need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to ensure better performance. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

The land capability units are Ilc-1, dryland, and I-4, irrigated; Silty range site; and windbreak suitability group 3.

**KeB—Keith loam, 1 to 3 percent slopes.** This very deep, very gently sloping, well drained soil is on uplands. It formed in loess. Areas range from 10 to 400 acres in size.

Typically, the surface layer is dark grayish brown, very friable loam about 9 inches thick. The subsoil is about 19 inches thick. The upper part is grayish brown and brown, firm silty clay loam, and the lower part is pale brown, friable, calcareous silty clay loam. The underlying material to a depth of 60 inches or more is light gray and very pale brown, calcareous silt loam. In some areas calcareous sandstone is at a depth of 40 to 60 inches. In a few places the surface soil is silt loam.

Included with this soil in mapping are small areas of Lodgepole and Satanta soils. Lodgepole soils have more clay in the subsoil than the Keith soil and are somewhat poorly drained. These soils are in upland depressions. Satanta soils have more sand in the subsoil than the Keith soil and are on similar landscapes. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Keith soil, and available water capacity is high. Runoff is slow. The organic matter content is moderate. Tilth is good. The water intake rate is moderately low.

Most of the acreage of this soil is farmed. About half of the cultivated areas are used for dryland farming, and the rest is irrigated. The remaining areas are used for range.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall generally limits the cultivated crops that can be successfully grown. Soil blowing and water erosion are hazards. A system of conservation tillage, such as stubble mulching and ecofallow, keeps crop residue on the surface and helps to conserve soil moisture. These practices also help to control soil blowing and water erosion after locally heavy rains. Returning crop residue and green manure crops to the soil helps to maintain the organic matter content and fertility.

Contour farming or stripcropping can also help to control soil blowing and water erosion. Summer fallowing conserves moisture for use during the following growing season.

If irrigated, this soil is suited to sugar beets, field beans, corn, small grains, alfalfa, and introduced grasses. It is suited to sprinkler and gravity irrigation systems. Some land leveling is needed for gravity irrigation systems. A system of conservation tillage, such as no-till or ecofallow, keeps crop residue on the surface and helps to control soil blowing and water erosion. Returning crop residue to the soil also helps to maintain the organic matter content and fertility and conserves soil moisture. Irrigation systems need to be designed so that the water application rate does not exceed the moderately low intake rate of this soil. A tailwater recovery system can be used to conserve irrigation water.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil blowing. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate rainfall is the principal hazard affecting seedlings and young trees. Seedlings can survive and grow if competing vegetation between the tree rows is controlled by cultivation with conventional equipment. The undesirable grasses and weeds in the rows can be

controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide. Planting an annual cover crop between the tree rows helps to control erosion. Irrigation can provide supplemental moisture during periods of low rainfall.

This soil is generally suited to sites for dwellings and buildings with basements. The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. Roads need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to ensure better performance. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

The land capability units are Ile-1, dryland, and Ile-4, irrigated; Silty range site; and windbreak suitability group 3.

**KeC—Keith loam, 3 to 6 percent slopes.** This very deep, gently sloping, well drained soil is on ridgetops and side slopes on uplands. It formed in loess. Areas range from 10 to about 100 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 6 inches thick. The subsoil is about 22 inches thick. It is dark grayish brown and grayish brown, friable silty clay loam in the upper part and pale brown, friable, calcareous silt loam in the lower part. The underlying material is light gray, calcareous silt loam to a depth of more than 60 inches. In some places the surface layer is silt loam. In some areas calcareous sandstone is at a depth of 40 to 60 inches. In cultivated areas 5 to 20 percent of this soil is eroded. In these areas erosion has removed all or most of the original surface soil, and tillage has mixed the remaining surface soil with the subsoil. In most places the surface layer is light in color and calcareous. In some places the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Satanta soils, which have more sand in the subsoil than the Keith soil and are on similar landscapes. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderate in the Keith soil, and available water capacity is high. Runoff is medium. The organic matter content is moderate. The water intake rate is moderately low.

Most of the acreage of this soil is dryland farmed. A few areas are irrigated. The rest is mainly used as range.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Soil blowing and water erosion are the principal hazards in areas where the surface is not protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, that keeps crop residue on the surface helps to control soil blowing and water erosion and helps to conserve soil moisture. Returning crop residue and green manure crops to the soil helps to maintain the organic matter content and fertility. Terracing and contour farming reduce the runoff rate and help to control water erosion. Summer fallowing conserves moisture for use during the following growing season.

If irrigated by a sprinkler system, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. Extensive land leveling is needed for gravity irrigation systems. Soil blowing and water erosion are the principal hazards. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control water erosion and soil blowing and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing and water erosion. Incorporating crop residue into the soil helps to maintain the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone and result in the hazard of water erosion on the slopes.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Continuous heavy grazing and improper haying also reduce the amount of protective cover and can result in soil blowing and the formation of small gullies and rills after heavy rains. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can

be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil blowing and water erosion. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate rainfall and soil erosion are the principal hazards affecting seedlings and young trees. Seedlings can survive and grow if competing vegetation between the tree rows is controlled by cultivation with conventional equipment. The undesirable grasses and weeds in the rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide. Planting an annual cover crop between the tree rows helps to control soil blowing and water erosion. Irrigation can provide supplemental moisture during periods of low rainfall.

This soil is generally suited to sites for dwellings and buildings with basements. The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. Roads and streets need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to ensure better performance. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

The land capability units are IIIe-1, dryland, and IIIe-4, irrigated; Silty range site; and windbreak suitability group 3.

**Kg—Keith loam, gravelly substratum, 0 to 1 percent slopes.** This very deep, nearly level, well drained soil is on uplands. This soil formed in loess deposited over gravelly sediment. Areas range from 5 to 320 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 7 inches thick. The subsurface layer

is dark grayish brown, friable loam about 5 inches thick. The subsoil is about 18 inches thick. It is grayish brown, friable clay loam in the upper part and light brownish gray, very friable, calcareous loam in the lower part. The underlying material is light gray, calcareous loam to a depth of 49 inches. Below this to a depth of 60 inches or more is white, calcareous gravelly coarse sand. In some places the dark surface soil is more than 20 inches thick. In some areas the surface soil is clay loam that is exposed during land leveling. In other areas the gravelly material is below a depth of 60 inches. In some places gravelly coarse sand is within a depth of 40 inches because of the cuts made during land leveling.

Included with this soil in mapping are small areas of Bridget soils, which are calcareous within 15 inches of the surface. These soils contain less clay in the solum than the Keith, gravelly substratum, soil and are lower on the landscape. Included soils make up about 5 to 10 percent of the unit.

Permeability is moderate in the solum and the underlying material in the Keith, gravelly substratum, soil and very rapid in the substratum. Available water capacity is moderate. The organic matter content is moderate. Runoff is slow. The water intake rate is moderately low.

Most of the acreage of this soil is used for irrigated crops. The rest is used mainly for dryland crops.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Soil blowing is a slight hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to conserve soil moisture and control soil blowing. Returning crop residue to the soil helps to maintain the organic matter content and the water intake rate.

If irrigated, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. It is suited to sprinkler and gravity irrigation systems. Some land leveling is generally needed for gravity systems to ensure the uniform distribution of water. Soil blowing is a slight hazard. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. Incorporating crop residue into the soil helps to maintain the organic matter content and fertility. Irrigation systems should be designed so that the water application rate does not exceed the moderately low intake rate of this soil. A tailwater recovery system can be used to conserve irrigation water.

This soil is suited to introduced grasses used as

pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants very effectively controls soil blowing. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate rainfall is the principal hazard affecting seedlings and young trees. Seedlings can survive and grow if competing vegetation between the tree rows is controlled by cultivation with conventional equipment. The undesirable grasses and weeds in the rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide. Planting an annual cover crop between the tree rows helps to control soil blowing. Irrigation can provide supplemental moisture during periods of low rainfall.

This soil is generally suited to sites for dwellings and buildings with basements. Because of the very rapid permeability of the gravelly substratum, this soil does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in pollution of the ground water. Mounding the site with several feet of suitable fill material improves the filtering capacity of the soil. The moderate permeability of this soil is a limitation affecting septic tank absorption fields, but increasing the size of the absorption field can generally overcome this limitation. The sides of shallow excavations can cave in unless they are shored. A good surface drainage system can minimize the damage to roads caused by frost action.

Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

The land capability units are Ilc-1, dryland, and I-4, irrigated; Silty range site; and windbreak suitability group 3.

**KgB—Keith loam, gravelly substratum, 1 to 3 percent slopes.** This very deep, very gently sloping, well drained soil is on uplands. This soil formed in loess deposited over gravelly sediment. Areas range from 10 to 100 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 8 inches thick. The subsoil is about 17 inches thick. It is grayish brown, firm clay loam in the upper part and brown, friable, calcareous loam in the lower part. The underlying material is light gray, calcareous loam to a depth of 45 inches. Below this to a depth of more than 60 inches is white, calcareous gravelly coarse sand. In a few places gravelly coarse sand is below a depth of 60 inches. In some areas the dark surface soil is more than 20 inches thick. In some places the surface layer is silt loam. In a few areas the surface layer is light in color or the gravelly substratum is within a depth of 40 inches because of the cuts made during land leveling.

Included with this soil in mapping are small areas of Bridget soils, which have less clay in the profile than the Keith, gravelly substratum, soil. These soils do not have a gravelly substratum. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the upper part of the profile in the Keith, gravelly substratum, soil and very rapid in the gravelly substratum. Available water capacity is moderate. The organic matter content is moderate. Runoff is slow. The water intake rate is moderately low.

Most of the acreage of this soil supports irrigated crops. A few areas are dryland farmed. A few small areas are used for grazing.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Water erosion and soil blowing are hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to conserve soil moisture and control soil blowing and water erosion. Returning crop residue to the soil helps improve the organic matter content, fertility, and the water intake rate.

If irrigated, this soil is suited to sugar beets, field beans, corn, small grains, alfalfa, and introduced

grasses. It is suited to sprinkler and gravity irrigation systems. Some land leveling is generally needed for gravity systems to ensure the uniform distribution of water. A system of conservation tillage, such as no-till or ecofallow, that keeps crop residue on the surface helps to control soil blowing and water erosion. Returning crop residue to the soil helps to maintain the organic matter content and fertility and improves the water intake rate. Irrigation systems need to be designed so that the water application rate does not exceed the moderately low intake rate of the soil. A tailwater recovery system can be used to conserve irrigation water.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil blowing. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate rainfall is the principal hazard affecting seedlings and young trees. Seedlings can survive and grow if competing vegetation between the tree rows is controlled by cultivation with conventional equipment. The undesirable grasses and weeds in the rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide. Planting an annual cover crop between the tree rows helps to control erosion. Irrigation can provide supplemental moisture during periods of low rainfall.

Because of the very rapid permeability of the gravelly substratum, this soil does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in pollution of the ground water. Mounding the site with several feet of suitable fill material improves the filtering capacity of the soil. The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. This soil is generally suited to sites for dwellings and buildings with basements. The sides of shallow excavations can cave in unless they are shored. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

The land capability units are 11e-1, dryland, and 11e-4, irrigated; Silty range site; and windbreak suitability group 3.

**KgC—Keith loam, gravelly substratum, 3 to 6 percent slopes.** This very deep, gently sloping, well drained soil is on uplands. The soil formed in loess deposited over gravelly sediment. Areas range from 5 to 50 acres in size.

Typically, the surface layer is dark grayish brown, very friable loam about 7 inches thick. The subsoil is about 16 inches thick. The upper part is grayish brown, firm clay loam, and the lower part is brown, friable, calcareous loam. The underlying material is pale brown, calcareous loam to a depth of 42 inches. Below this to a depth of 60 inches or more is pale brown, calcareous gravelly coarse sand. In a few places gravelly material is below a depth of 60 inches. In some places the surface layer is silt loam. In a few small areas the light colored subsoil or gravelly coarse sand is exposed at the surface because of the cuts made during land leveling.

Included with this soil in mapping are small areas of Jayem and Satanta soils. The included soils have more sand in the subsoil than the Keith, gravelly substratum, soil. They are on similar landscapes. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the upper part of the profile in the Keith, gravelly substratum, soil and very rapid in the gravelly substratum. Available water capacity is moderate. The organic matter content is moderate. Runoff is medium. The water intake rate is moderately low.

Most of the acreage of this soil is irrigated cropland. A few areas are dryland farmed.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. The lack of adequate rainfall commonly limits the cultivated crops that can

be grown successfully. Soil blowing and water erosion are the principal hazards in areas where the surface is not protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, that keeps crop residue on the surface helps to control erosion and conserve soil moisture. Returning crop residue to the soil also helps to maintain the organic matter content and fertility. Terracing and contour farming reduce the runoff rate and help to control erosion. Summer fallowing conserves moisture for use during the following growing season.

If irrigated by a sprinkler system, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. Extensive land leveling is needed for gravity irrigation systems. Soil blowing and water erosion are the principal hazards. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control water erosion and soil blowing and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing and water erosion. Incorporating crop residue into the soil improves the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients and result in the hazard of water erosion on the slopes.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. This soil is subject to water erosion. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Continuous heavy grazing and improper haying also reduce the amount of protective cover and can result in soil blowing and the formation of small gullies and rills after heavy rains. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants

effectively controls soil blowing. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate rainfall and soil erosion are the principal hazards affecting seedlings and young trees. Seedlings can survive and grow if competing vegetation between the tree rows is controlled by cultivation with conventional equipment. The undesirable grasses and weeds in the rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide. Planting an annual cover crop between the tree rows helps to control soil blowing and water erosion. Planting trees on the contour helps to control water erosion. Irrigation can provide supplemental moisture during periods of low rainfall.

Because of the very rapid permeability of the gravelly substratum, this soil does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in pollution of the ground water. Mounding the site with several feet of suitable fill material improves the filtering capacity of the soil. The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. This soil is generally suited to sites for dwellings and buildings with basements. The sides of shallow excavations can cave in unless they are shored. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

The land capability units are Ille-1, dryland, and Ille-4, irrigated; Silty range site; and windbreak suitability group 3.

**Ky—Keya loam, 0 to 2 percent slopes.** This very deep, nearly level, well drained soil is in upland swales. The soil formed in local loamy alluvium. Areas range from 10 to 150 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 6 inches thick. The subsurface layer is about 11 inches thick. It is similar to the surface layer in color and texture. The subsoil is about 32 inches thick. It is dark grayish brown and grayish brown, firm clay loam in the upper part and pale brown, friable, calcareous loam in the lower part. The

underlying material is very pale brown, calcareous loam to a depth of more than 60 inches. In a few areas the surface layer is fine sandy loam, very fine sandy loam, or loamy fine sand. In some places calcareous sandstone is at a depth of 40 to 60 inches. In some areas strata of gravelly sand is below a depth of 40 inches.

Included with this soil in mapping are small areas of Duroc, Tuthill, and Vetal soils. Duroc soils contain less sand in the profile than the Keya soil and are on similar landscapes. Tuthill soils have a dark surface soil less than 20 inches thick and have fine sand at a depth of 20 to 40 inches. These soils are higher on the landscape than the Keya soil. Vetal soils have more sand in the profile than the Keya soil and are on similar landscapes. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Keya soil, and available water capacity is high. Runoff is slow. The organic matter content is moderate. The surface layer is easily tilled throughout a wide range of moisture content. The water intake rate is moderate.

Most of the acreage of this soil is dryland farmed, and a few acres are irrigated. The rest of the acreage is used for range.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Soil blowing is a slight hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to control soil blowing and conserve soil moisture. Returning crop residue to the soil helps to maintain the organic matter content and fertility and improves the water intake rate.

If irrigated, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. It is suited to sprinkler and gravity irrigation systems. Some land leveling is generally needed for gravity systems to ensure the uniform distribution of water. Soil blowing is a slight hazard. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. Returning crop residue to the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be

seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler or gravity systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil blowing. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate rainfall is the principal hazard affecting seedlings and young trees. Seedlings can survive and grow if competing vegetation between the tree rows is controlled by cultivation with conventional equipment. The undesirable grasses and weeds in the rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide. Irrigation can provide supplemental moisture during periods of low rainfall.

The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. Strengthening the foundations of buildings and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

The land capability units are IIc-1, dryland, and I-4, irrigated; Silty range site; and windbreak suitability group 3.

#### **La—Las Animas loam, 0 to 2 percent slopes.**

This very deep, nearly level, somewhat poorly drained soil is on bottom land. It is subject to occasional

flooding. The soil formed in stratified, calcareous loamy and sandy alluvium. Areas range from 5 to 40 acres in size.

Typically, the surface layer is gray, very friable, calcareous loam about 5 inches thick. The underlying material extends to a depth of 60 inches or more. It is light gray, mottled, calcareous very fine sandy loam in the upper part and light gray, mottled fine sand stratified with calcareous very fine sandy loam in the lower part. In some places the surface layer is loamy fine sand, fine sandy loam, or very fine sandy loam. In other places sandy material is within a depth of 40 inches. In a few areas a dark surface soil is more than 7 inches thick.

Included with this soil in mapping are small areas of Bolent and Calamus soils. The included soils have more sand in the profile than the Las Animas soil. Bolent soils are on similar landscapes as the Las Animas soil. Calamus soils are moderately well drained and are higher on the landscape than the Las Animas soil. Some areas are moderately affected or strongly affected by sodium. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Las Animas soil, and available water capacity is moderate. The organic matter content is moderately low. Runoff is slow. The water intake rate is moderately high. This soil has a seasonal high water table that ranges from a depth of 1.5 feet during wet years to 3.0 feet during most dry years.

Most of the acreage of this soil is used as range and hayland.

If this soil is used as range or hayland, the climax vegetation is dominantly big bluestem, little bluestem, indiangrass, switchgrass, and sedges. These species make up 60 percent or more of the total annual forage. Prairie cordgrass, bluegrass, rushes, and forbs make up the rest. If subject to continuous heavy grazing or improperly harvested for hay, big bluestem, little bluestem, indiangrass, switchgrass, and prairie cordgrass decrease in abundance and are replaced by western wheatgrass, bluegrass, slender wheatgrass, green muhly, sedges, and rushes. If overgrazing or improper haying continues for many years, bluegrass, sedges, rushes, and forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 1.6 animal unit months per acre. A planned grazing system that includes proper grazing use, timely deferments from grazing and haying, and restricted use during wet periods helps to maintain or improve the range condition. Areas of this soil are generally the first to be overgrazed in a pasture that includes the better drained, sandy soils. Properly located fences and livestock watering and salting

facilities result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. The hay is of best quality when the grasses are cut early.

This soil is suited to the trees and shrubs planted in windbreaks. The main limitation affecting the establishment of windbreaks is the wetness caused by the high water table. The species selected for planting should be those that can withstand the occasional wetness. Tilling and planting seedlings should be delayed until after the soil has begun to dry. Seedlings can survive and grow if competing vegetation between the tree rows is controlled by cultivation with conventional equipment. The undesirable grasses and weeds in the rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide.

This soil is not suited to sanitary facilities and building sites because of the flooding. A suitable alternative site should be selected. The sides of shallow excavations can cave in unless they are shored. The excavations should be made during dry periods. Constructing roads on suitable, well compacted fill material above the flood level, providing adequate side ditches, and installing culverts help protect roads from the damage caused by floodwater and the wetness caused by the seasonal high water table.

The land capability units are Ilw-4, dryland, and Ilw-8, irrigated; Subirrigated range site; and windbreak suitability group 2S.

#### **Lg—Lodgepole silt loam, 0 to 1 percent slopes.**

This very deep, nearly level, somewhat poorly drained soil is in depressions on uplands. It formed in loess and loamy sediments. It is occasionally ponded for short periods by runoff from the adjacent uplands. Areas range from 5 to 15 acres in size.

Typically, the surface layer is dark gray, friable silt loam about 5 inches thick. The subsoil is about 35 inches thick. The upper part is dark gray and grayish brown, very firm silty clay, and the lower part is pale brown, friable, mottled loam. The underlying material to a depth of 60 inches or more is light gray, calcareous loam in the upper part and very pale brown, calcareous fine sandy loam in the lower part. In some places the surface layer is loam. In other places sandy underlying material is within a depth of 40 inches. In a few areas of this soil on the Mirage Flats, gravelly coarse sand is below a depth of 40 inches.

Included with this soil in mapping are small areas of

Duroc and Onita soils. Duroc soils have less clay in the subsoil than the Lodgepole soil and are better drained. These soils are higher on the landscape. Onita soils are moderately well drained and are higher on the landscape than the Lodgepole soil. Included soils make up about 5 percent of the unit.

Permeability is very slow in the Lodgepole soil. Available water capacity is high, and the organic matter content is moderate. Runoff is ponded for a brief period. The water intake rate is low. This soil has a perched water table that ranges from 0.5 foot above the surface during wet years to about 1.0 foot below the surface during dry years. The surface layer is saturated for long periods in most years by the perched water table.

Most of the acreage of this soil is used as cropland. A few areas are used for range.

If dryland farmed, this soil is poorly suited to small grains, introduced grasses, and alfalfa. The wetness caused by the perched water table is the principal hazard. A system of conservation tillage, such as stubble mulching, keeps crop residue on the surface, helps to conserve soil moisture, and controls soil blowing during periods when the soil is not ponded. Returning crop residue to the soil helps to maintain or improve the organic matter content and fertility and also improves the water intake rate.

If irrigated, this soil is poorly suited to corn and alfalfa. The wetness caused by the perched water table and the ponding are management concerns. This soil is suited to sprinkler and gravity irrigation systems, but it is best suited to sprinkler systems. Adjusting the application rate to the low water intake rate helps to prevent the ponding. Other management practices are similar to those used if this soil is dryland farmed.

This soil is poorly suited to introduced grasses used as pasture and hayland. These grasses can be rotated with other crops. Continuous heavy grazing or grazing during wet periods causes compaction and poor tilth. Excessive wetness limits the choice of pasture grasses and legumes. Grazing when the soil is too wet results in damage to the grass stand. Because of the wetness, establishing a good stand of grass can be difficult. Managing separate pastures of cool- and warm-season grasses can extend the grazing season.

This soil is suited to native grasses used as range and hayland. Overgrazing by livestock, improper haying periods, or improper mowing heights reduces the protective vegetative cover and the quality of the native plants. Proper degree of use, a planned grazing system, and timely deferments from grazing or haying help to maintain or improve the range condition. Rotation grazing and proper stocking rates help to maintain the grasses in good condition.

This soil is suited to the trees and shrubs planted in windbreaks. The wetness caused by the perched water table and the ponding are major concerns affecting the establishment of windbreaks. The species selected for planting should be those that can withstand the occasional wetness. Onsite investigation is needed to identify the areas that are best suited to windbreaks.

This soil is not suited to sites for septic tank absorption fields or buildings because of the ponding. A suitable alternative site should be selected. Constructing roads on suitable, well compacted fill material above the level of ponding, providing adequate side ditches, and installing culverts help protect roads from the damage caused by flooding. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance. Mixing the base material with additives, such as hydrated lime, can help to prevent excessive shrinking and swelling.

The land capability units are Illw-2, dryland, and IVw-2, irrigated; Clayey Overflow range site; and windbreak suitability group 2W.

**Lu—Lute loam, 0 to 2 percent slopes.** This very deep, nearly level, somewhat poorly drained soil is on alluvial fans and low stream terraces. It formed in loamy alluvium. This soil is subject to rare flooding. Areas range from 5 to 200 acres in size.

Typically, the surface layer is dark gray, friable loam about 6 inches thick. The subsurface layer is light brownish gray, friable loam about 1 inch thick. The subsoil is about 17 inches thick. It is gray, firm, calcareous sandy clay loam in the upper part and grayish brown, very friable, calcareous, mottled very fine sandy loam in the lower part. The underlying material is stratified light gray, calcareous very fine sandy loam to a depth of 60 inches or more. In some places the surface layer is fine sandy loam or loamy fine sand. In other places the subsoil is clay loam. In other places the underlying material is stratified loam or clay loam.

Included with this soil in mapping are small areas of Beckton and Satanta soils. Beckton soils are moderately well drained and are higher on the landscape than the Lute soil. Satanta soils are well drained and are not sodium-affected. These soils are higher on the landscape than the Lute soil. Included soils make up 5 to 10 percent of the unit.

Permeability is slow in the subsoil in the Lute soil and moderately rapid in the underlying material. Available water capacity is moderate. The organic

matter content is moderate. Runoff is slow. This soil has poor tilth. It takes in water slowly, and water may accumulate in the microdepressions for short periods. This soil has a high content of sodium. It has a perched water table that ranges from a depth of about 1 foot to 3 feet.

All of the acreage of this soil supports native grasses used for hay or grazing.

This soil is not suited to farming because of the high content of sodium.

If this soil is used as range, either for grazing or hay, the climax vegetation is dominated by cordgrass, inland saltgrass, and western wheatgrass. These species make up 90 percent or more of the total annual forage. Foxtail barley, slender wheatgrass, switchgrass, bluegrass, sedges, and forbs make up the rest. If subject to continuous heavy grazing or improperly harvested for hay, alkali sacaton, western wheatgrass, and switchgrass decrease in abundance and are replaced by inland saltgrass, blue grama, bluegrass, foxtail barley, sand dropseed, and alkali tolerant sedges. If overgrazing or improper haying continues for many years, inland saltgrass, blue grama, bluegrass, foxtail barley, alkali tolerant sedges, rushes, and forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain and improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. The alkalinity limits forage production and greatly influences the kinds of plants that grow. Some areas of very strongly alkaline soils support little or no vegetation and are subject to a severe hazard of soil blowing during dry periods. Careful management is needed to maintain the plant cover.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous.

This soil is not suited to the trees and shrubs planted in windbreaks. A few areas may be suitable for the trees or shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used.

Constructing septic tank absorption fields on fill material raises the fields a sufficient distance above the seasonal high water table. Constructing dwellings and buildings on raised, well compacted fill material helps to overcome the wetness caused by the high water table and helps to prevent the damage caused by floodwater. The sides of shallow excavations can

cave in unless they are shored. The excavations should be made during dry periods. A good surface drainage system and a gravel moisture barrier in the subgrade can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. Constructing roads on suitable, well compacted fill material above the flood level, providing adequate side ditches, and installing culverts help to prevent the damage to roads caused by the flooding and the wetness.

The land capability unit is VIs-1, dryland; Saline Subirrigated range site; and windbreak suitability group 10.

**MbC—Manvel silty clay loam, 2 to 6 percent slopes.** This very deep, gently sloping, well drained soil is on alluvial fans and foot slopes. It formed in calcareous colluvial and alluvial sediments derived from interbedded chalk and shale. Areas range from 20 to 600 acres in size.

Typically, the surface layer is light brownish gray, friable, calcareous silty clay loam about 5 inches thick. The transitional layer is light brownish gray, friable, calcareous silty clay loam about 6 inches thick. The underlying material is calcareous silty clay loam to a depth of more than 60 inches. The upper part is light gray, and the lower part is pale yellow. In some places the surface layer is silt loam or loam. In some areas interbedded chalk and shale is at a depth of 40 to 60 inches. In other places the underlying material is strongly alkaline.

Included with this soil in mapping are small areas of Bufton soils, which contain more clay than the Manvel soil and are higher on the landscape. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow in the Manvel soil. Available water capacity is high. The organic matter content is moderately low. Runoff is slow and medium. The water intake rate is moderate.

Most of the acreage of this soil is used as dryland cropland. The rest supports native grasses used for range.

If dryland farmed, this soil is poorly suited to small grains, introduced grasses, and alfalfa. The lack of adequate seasonal rainfall commonly limits the cultivated crops that can be grown. Soil erosion is the principal hazard if the surface is not protected by crops or crop residue. A system of conservation tillage, such as stubble mulching, ecofallow, and stripcropping, that keeps crop residue on the surface helps to control water erosion and soil blowing and conserve soil moisture. Returning crop residue to the soil also helps to maintain the organic matter content

and fertility. Summer fallowing conserves moisture for use during the following growing season. Terraces and contour farming help to control water erosion.

If irrigated, this soil is poorly suited to alfalfa, small grains, and introduced grasses. It is suited to sprinkler and gravity irrigation systems. Extensive land leveling is needed for gravity systems to ensure the uniform distribution of water. Timely application and efficient distribution of water are needed. Erosion control practices are similar to those used if this soil is dryland farmed.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with other crops. Rotation grazing and proper stocking help to maintain or improve the condition of the grasses. Managing separate pastures of cool- and warm-season grasses can extend the grazing season.

If this soil is used as range, the climax vegetation is dominated by blue grama, needlegrass, and threadleaf sedge. These species make up 70 percent or more of the total annual production. Buffalograss, western wheatgrass, little bluestem, sideoats grama, prairie sandreed, and other annual and perennial grasses, forbs, and shrubs make up the rest. If subject to continuous heavy grazing, little bluestem decreases in abundance. Initially, this species is replaced by blue grama, hairy grama, prairie sandreed, sand dropseed, western wheatgrass, needleandthread, plains muhly, Sandberg bluegrass, sedges, annual grasses, and forbs. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.6 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities, roads, and trails. The areas away from the watering facilities may be underused. Properly locating fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time salt is provided help to prevent excessive trampling and local overuse. Areas previously used as cropland should be reseeded to a suitable grass mixture. In areas where gullies have formed because of severe water erosion, land shaping or other mechanical practices may be required in addition to deferments from grazing to stabilize the site before it is reseeded.

This soil is suited to the trees and shrubs planted in

windbreaks. The species selected for planting should be those that can tolerate a high amount of calcium in the soil. The lack of adequate rainfall is a hazard. Irrigation may be needed to provide supplemental moisture during periods of low rainfall. Planting the trees on the contour and terracing help to control water erosion. Seedlings can survive and grow if competing vegetation between the tree rows is controlled by cultivation with conventional equipment. The undesirable grasses and weeds in the rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide.

The moderately slow permeability of this soil is a limitation affecting septic tank absorption fields, but increasing the size of the absorption field can generally overcome this limitation. Strengthening the foundations of buildings and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. Roads and streets need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil material. Coarse grained, loose material can be used to ensure better performance.

The land capability units are IVe-1, dryland, and IVe-3, irrigated; Limy Upland range site; and windbreak suitability group 8.

**Mc—Marlake fine sandy loam, 0 to 1 percent slopes.** This very deep, nearly level, very poorly drained soil is in depressions in sandhill valleys. It formed in eolian sand and sandy alluvium. This soil is subject to frequent ponding by water from a high water table. Individual areas range from 5 to 600 acres in size.

Typically, the surface layer is dark gray, very friable, calcareous fine sandy loam about 7 inches thick. The transitional layer is about 7 inches thick. It is grayish brown, very friable, calcareous loamy fine sand stratified with fine sandy loam and fine sand. The underlying material to a depth of more than 60 inches is light brownish gray, mottled, calcareous loamy fine sand stratified with fine sandy loam and fine sand. In some places the underlying material is not stratified. In a few places the surface layer is loamy fine sand or fine sand. In a few areas the underlying material is fine sandy loam.

Included with this soil in mapping are small areas of Els, Hoffland, and Tryon soils and a few intermittent lakes. The included soils have a lower seasonal high water table than the Marlake soil and are higher on the

landscape. Hoffland soils have a surface soil that has a high content of carbonates. Inclusions make up 5 to 10 percent of this unit.

Permeability is rapid in the Marlake soil, and available water capacity is low. The organic matter content is high. Runoff is ponded. This soil has a seasonal high water table that ranges from 2 feet above the surface during wet years to 1 foot below the surface during dry years. This soil has water above the surface for long periods during most years. During extended dry periods the water table normally recedes below the surface.

This soil is used as wildlife habitat (fig. 12). Vegetation consists of cattails, rushes, sedges, and other native marsh vegetation.

This soil is too wet for cropland, pasture, or range and for trees and shrubs.

This soil is not suited to septic tank absorption fields or building sites because of the wetness caused by the high water table and the ponding of water on the surface. A suitable alternative site should be selected. Constructing roads on suitable, well compacted fill material above the level of ponding, providing adequate side ditches, and installing culverts help protect roads from the damage caused by ponding and the wetness caused by the seasonal high water table.

The land capability unit is VIIIw-7, dryland, and windbreak suitability group 10. No range site is assigned.

**Mk—McCook loam, 0 to 2 percent slopes.** This very deep, nearly level, well drained soil is on bottom land. It is subject to rare flooding. The soil formed in stratified, calcareous, loamy alluvium. Areas range from 5 to 200 acres in size.

Typically, the surface layer is grayish brown, friable, calcareous loam about 6 inches thick. The subsurface layer is grayish brown, friable, calcareous loam about 6 inches thick. The transitional layer is stratified, light brownish gray, very friable, calcareous loam about 8 inches thick. Below the transitional layer is a buried surface layer about 13 inches thick that is dark grayish brown, very friable, calcareous loam. The underlying material to a depth of about 45 inches is pale brown, calcareous loam. Below this to a depth of 60 inches or more is another buried surface layer that is grayish brown, calcareous silt loam. In some places carbonates are below a depth of 10 inches. In some areas the dark surface soil is more than 20 inches thick. In some places the surface layer is fine sandy loam or silt loam.

Included with this soil in mapping are small areas of Munjor soils, which have more sand in the profile than

the McCook soil and are on similar landscapes. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the McCook soil, and available water capacity is high. The organic matter content is moderate. Runoff is slow. The water intake rate is moderate.

Most of the acreage of this soil is cultivated, and many areas are irrigated. Only a small acreage is used as range.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Soil blowing is a hazard in areas where the surface is not adequately protected by crops or crop residue. This soil is flooded for short periods, and damage to crops is seldom severe. A system of conservation tillage, such as stubble mulching and ecofallow, helps to conserve soil moisture and control soil blowing. The use of cover crops during the winter also helps to control soil blowing. Returning crop residue to the soil helps improve the organic matter content and the water intake rate.

If irrigated, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. It is suited to sprinkler and gravity irrigation systems. Some land leveling is generally needed for gravity systems to ensure the uniform distribution of water. This soil is flooded for short periods, and damage to crops is seldom severe. Soil blowing is the principal hazard. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone.

This soil is suited to introduced grasses used for pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by



Figure 12.—An area of Marlake fine sandy loam, 0 to 1 percent slopes, used as wetland wildlife habitat.

supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range and native hayland. A cover of range plants effectively controls soil blowing and water erosion. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants.

This soil is suited to the trees and shrubs planted in windbreaks. Competing weeds and grasses can be controlled by cultivation with conventional equipment between the tree rows and by hoeing by hand,

rototilling, and the careful use of the appropriate kind of herbicide in the rows. Irrigation is needed during dry periods.

The hazard of rare flooding needs to be considered if this soil is used for sanitary facilities and building sites. The moderate permeability of this soil is a limitation affecting septic tank absorption fields, but increasing the size of the absorption fields can generally overcome this limitation. Constructing dwellings and buildings on raised, well compacted fill material helps to prevent the damage caused by floodwater. Constructing roads on suitable, well compacted fill material above the flood level, providing adequate side ditches, and installing culverts help protect roads from the damage caused by floodwater. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

The land capability units are 11c-1, dryland, and 1-6, irrigated; Silty Lowland range site; and windbreak suitability group 1L.

**Mm—McCook loam, channeled, 0 to 2 percent slopes.** This very deep, nearly level, well drained soil is on bottom land. It formed in stratified, calcareous, loamy alluvium. This soil has an entrenched, meandering stream channel and is subject to frequent flooding. Areas range from 20 to 200 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 10 inches thick. The lower part of the surface layer is calcareous. The transitional layer is pale brown, very friable, calcareous loam about 5 inches thick. The underlying material extends to a depth of 60 inches or more. It is pale brown, calcareous loam in the upper part and light gray, calcareous loam in the lower part. In some places the carbonates are below a depth of 10 inches. In some areas the dark surface soil is more than 20 inches thick. In some places gravelly fine sandy loam is in the underlying material.

Included with this soil in mapping are small areas of Munjor soils, which contain more sand than the McCook soil and are on similar landscapes. Also included are some areas of short, steep slopes along the edges of the channels. Inclusions make up 5 to 10 percent of the unit.

Permeability is moderate in the McCook soil, and available water capacity is high. The organic matter content is moderate. Runoff is slow.

All of the acreage of this unit supports native grasses and is used as range or hayland.

This soil is not suited to farming because of the hazard of frequent flooding. In most places the channels are too steep to be crossed by conventional equipment.

If this soil is used as range or hayland, the climax vegetation is dominantly big bluestem, little bluestem, sideoats grama, and western wheatgrass. These species make up about 70 percent of the total annual forage. Prairie junegrass, switchgrass, green needlegrass, bluegrass, sedges, and forbs make up the rest. If subject to continuous heavy grazing, big bluestem, little bluestem, prairie junegrass, and green needlegrass decrease in abundance and are replaced by western wheatgrass, bluegrass, and sedges. Although flooding is very brief, the floodwater deposits debris and weed seeds. Grazing should be delayed on this soil after periods of flooding to prevent compaction.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing

use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing.

If this soil is used as hayland, the forage can generally be harvested annually. Mowing should be regulated so that the grasses remain vigorous and healthy.

This soil is not suited to the trees and shrubs planted in windbreaks because of the hazard of flooding. A few areas may be suitable for the trees or shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used.

This soil is not suited to building sites or septic tank absorption fields because of the flooding. Suitable alternative sites should be selected. Constructing roads on suitable, well compacted fill material above the flood level, providing adequate side ditches, and installing culverts help protect roads from the damage caused by floodwater.

The land capability unit is 11w-7, dryland; Silty Overflow range site; and windbreak suitability group 10.

**MxF—Mitchell-Epping complex, 9 to 30 percent slopes.** These moderately steep and steep, well drained soils are on uplands. The Mitchell soil is very deep, and the Epping soil is shallow. These soils formed in loamy sediment weathered from siltstone. The Mitchell soil is mainly on the middle and lower side slopes. The Epping soil is on the upper side slopes and on narrow ridgetops and knolls. Areas range from 20 to 500 acres in size. They consist of 50 to 65 percent Mitchell soil and 25 to 40 percent Epping soil. These soils are so intermingled or mixed that separating them in mapping is not practical.

Typically, the Mitchell soil has a surface layer of light brownish gray, very friable, calcareous very fine sandy loam about 4 inches thick. The transitional layer is pale brown, very friable, calcareous very fine sandy loam about 5 inches thick. The underlying material is very pale brown, calcareous very fine sandy loam to a depth of more than 60 inches. In some places the surface layer is loam, silt loam, or fine sandy loam. In other places the siltstone is at a depth of 40 to 60 inches.

Typically, the Epping soil has a surface layer of light brownish gray, very friable very fine sandy loam about 3 inches thick. The transitional layer is pale brown, very friable, calcareous very fine sandy loam about 3 inches thick. The underlying material is very pale

brown, calcareous very fine sandy loam to a depth of 15 inches. Below this to a depth of more than 60 inches is very pale brown siltstone. In some places the surface layer is loam or silt loam.

Included with these soils in mapping are small areas of Thirtynine soils and areas of Badland, which are lower on the landscape than the Mitchell and Epping soils. Thirtynine soils have a thicker and darker surface soil than that of the Mitchell and Epping soils and more clay in the profile. Areas of Badland, which is barren, occur as highly erodible areas of siltstone. Included areas make up 10 to 15 percent of the unit.

Permeability is moderate in the Mitchell and Epping soils. Available water capacity is high in the Mitchell soil and very low in the Epping soil. The organic matter content is moderately low in both soils. Runoff is rapid. Root development is restricted by the underlying siltstone in the Epping soil.

These soils support native grasses and are used as range.

These soils are not suited to cropland because of the steep slope and the shallow root zone of the Epping soil.

If these soils are used as range or hayland, the climax vegetation on the Mitchell soil is dominantly little bluestem, big bluestem, sideoats grama, and blue grama. These species make up 50 percent or more of the total annual forage. Plains muhly, buffalograss, needleandthread, western wheatgrass, and forbs make up the rest. The climax vegetation on the Epping soil is dominantly little bluestem, sideoats grama, western wheatgrass, blue grama, and threadleaf sedge. These species make up 70 percent or more of the total annual forage. Prairie sandreed, hairy grama, sand bluestem, big bluestem, needleandthread, green needlegrass, and forbs make up the rest. If subject to continuous heavy grazing, big bluestem and little bluestem decrease in abundance on the Mitchell soil and little bluestem, sand bluestem, and big bluestem decrease in abundance on the Epping soil. They are replaced by hairy grama, prairie sandreed, tall dropseed, western wheatgrass, needleandthread, plains muhly, sedges, and forbs on the Mitchell soil and sideoats grama, blue grama, hairy grama, prairie sandreed, sand dropseed, threadleaf sedge, and forbs on the Epping soil. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, water erosion is excessive. Woody plants may invade the site on the Epping soil.

If the range is in excellent condition, the suggested initial stocking rate is 0.6 animal unit month per acre on the Mitchell soil and 0.5 animal unit month per acre on the Epping soil. The stocking rate is determined by

the percentage of each soil in the pasture. The range should be closely monitored during use and the stocking rates adjusted so that one soil does not become overgrazed.

A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. The slope can hinder the movement of livestock. Brush management may be needed in some areas to control the woody plants that invade the site. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range. In areas where gullies have formed because of severe water erosion, land shaping or other mechanical practices may be needed to smooth and stabilize the site before it is reseeded.

These soils are generally not suited to the trees and shrubs planted in windbreaks because of the steep slope and the shallow depth to bedrock in the Epping soil. A few areas may be suitable for the trees and shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used.

These soils are generally not suitable for sanitary facilities because of the steep slope and the shallow depth to bedrock in the Epping soil. In areas of the Mitchell soil, dwellings and buildings need to be properly designed so that they conform to the natural slope of the land, or the soil can be graded to a suitable gradient. In areas of the Epping soil, the soft bedrock generally can be excavated during the construction of dwellings with basements or buildings that have deep foundations. Cutting and filling generally can provide a suitable grade for roads. The siltstone in areas of the Epping soil can be excavated during the construction of roads.

The land capability units are V1e-9, dryland, for the Mitchell soil and V1s-4, dryland, for the Epping soil. The Mitchell soil is in the Limy Upland range site, and the Epping soil is in the Shallow Limy range site. Both soils are in windbreak suitability group 10.

**My—Munjor fine sandy loam, 0 to 2 percent slopes.** This very deep, nearly level, well drained soil is on bottom land. The soil formed in stratified loamy and sandy alluvium. It is subject to rare flooding. Areas range from 5 to 150 acres.

Typically, the surface layer is grayish brown, very friable, calcareous fine sandy loam about 6 inches thick. The calcareous underlying material is stratified brown loamy very fine sand and pale brown fine sandy

loam to a depth of more than 60 inches. In some places the surface layer is loam, very fine sandy loam, sandy loam, or loamy fine sand. In other places carbonates are below a depth of 10 inches.

Included with this soil in mapping are small areas of Bolent, Las Animas, and McCook soils. Bolent soils have more sand in the profile than the Munjor soil and are somewhat poorly drained. These soils are lower on the landscape. Las Animas soils are somewhat poorly drained and are lower on the landscape than the Munjor soil. McCook soils have less sand than the Munjor soil and are on similar landscapes. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Munjor soil, and available water capacity is moderate. The organic matter content is low. Runoff is slow. The water intake rate is moderately high.

Most of the acreage of this soil is used as range or hayland. Some areas are cultivated.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Soil blowing is the main hazard. This soil is flooded for short periods, and damage to crops is seldom severe. A system of conservation tillage, such as stubble mulching and ecofallow, helps to conserve soil moisture and control soil blowing. The use of cover crops during the winter also helps to control soil blowing. Returning crop residue to the soil helps to maintain the organic matter content and fertility and improves the water intake rate.

If irrigated, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. It is suited to sprinkler and gravity irrigation systems. This soil is best suited to sprinkler irrigation systems because of the moderately high water intake rate. Frequent, light applications of irrigation water are needed. This soil is flooded for short periods, and damage to crops is seldom severe. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone.

If this soil is used as range or hayland, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, needleandthread, and switchgrass. These species make up 65 percent or more of the total annual forage. Blue grama, prairie

junegrass, bluegrass, indiangrass, sedges, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, indiangrass, little bluestem, and switchgrass decrease in abundance and are replaced by prairie sandreed, needleandthread, sand dropseed, blue grama, sedges, and forbs. If overgrazing continues for many years, blue grama, sand dropseed, needleandthread, Scribner panicum, sedges, and forbs dominate the site. Under these conditions, the native plants lose vigor and are unable to stabilize the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, mowing should be regulated so that the grasses remain healthy and vigorous. The forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and soil blowing are the main hazards affecting the establishment of windbreaks. Soil blowing can be controlled by maintaining strips of sod or a cover crop between the tree rows. The weeds and undesirable grasses in the tree rows can be controlled by the careful use of the appropriate kind of herbicide or hoeing by hand. Cultivation between the rows with conventional equipment can control undesirable grasses and weeds in areas where strips of sod and cover crops are not used. Irrigation can provide supplemental moisture during periods of low rainfall.

The hazard of rare flooding needs to be considered if this soil is used for sanitary facilities and building sites. Constructing dwellings and buildings on raised, well compacted fill material helps to prevent the damage caused by floodwater. The sides of shallow excavations can cave in unless they are shored. Constructing roads on suitable, well compacted fill material above the flood level, providing adequate side ditches, and installing culverts help protect roads from the damage caused by floodwater.

The land capability units are 11e-3, dryland, and 11e-8, irrigated; Sandy Lowland range site; and windbreak suitability group 1L.

**Mz—Munjor fine sandy loam, channeled, 0 to 2 percent slopes.** This very deep, well drained, nearly level soil is on bottom land along drainageways. The soil formed in stratified loamy and sandy alluvium. It has an entrenched, meandering stream channel and is subject to frequent flooding. Areas are generally long and narrow and range from 20 to 200 acres in size.

Typically, the surface layer is grayish brown, friable fine sandy loam about 5 inches thick. The underlying material to a depth of more than 60 inches is stratified and calcareous. It is light brownish gray, grayish brown, and light gray fine sandy loam in the upper part and light brownish gray loamy very fine sand and loamy fine sand in the lower part. In some places the surface layer is very fine sandy loam, loamy very fine sand, or loam.

Included with this soil in mapping are small areas of McCook and Las Animas soils. McCook soils have a dark surface soil more than 10 inches thick and have more silt in the profile than the Munjor soil. These soils are on similar landscapes. Las Animas soils are somewhat poorly drained and are lower on the landscape than the Munjor soil. Also included are some areas of short, steep slopes along the edges of the channels. Included areas make up 5 to 10 percent of the unit.

Permeability is moderately rapid in the Munjor soil, and available water capacity is moderate. The organic matter content is low. Runoff is slow.

All of the acreage of this soil is used for range. Most of the soil is covered by trees. The dominant vegetation is green ash, boxelder, hackberry, and eastern cottonwood.

This soil is not suited to cropland because of the hazard of frequent flooding.

If this soil is used as range or hayland, the climax vegetation is dominantly prairie sandreed, little bluestem, switchgrass, and sand bluestem. These species make up about 55 percent of the total annual forage. Prairie junegrass, big bluestem, sideoats grama, green needlegrass, western wheatgrass, bluegrass, sedges, and forbs make up the rest. If subject to continuous heavy grazing, big bluestem, little bluestem, prairie junegrass, and green needlegrass decrease in abundance and are replaced by western wheatgrass, bluegrass, and sedges. Although flooding is very brief, the floodwater deposits debris and weed seeds. Grazing should be delayed on this soil after periods of flooding to prevent compaction.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying

helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing.

If this soil is used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy.

This soil generally is not suited to the trees and shrubs planted in windbreaks because of the hazard of frequent flooding. A few areas may be suitable for the trees or shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used.

This soil is not suited to septic tank absorption fields and building sites because of the flooding. A suitable alternative site should be selected. The sides of shallow excavations can cave in unless they are shored. Constructing roads on suitable, well compacted fill material above the flood level, providing adequate side ditches, and installing culverts help protect roads from the damage caused by floodwater.

The land capability unit is Vlw-7, dryland; Sandy Lowland range site; and windbreak suitability group 10.

**OhC—Oglala-Canyon complex, 3 to 6 percent slopes.** These gently sloping, well drained soils are on uplands. The Oglala soil is deep, and the Canyon soil is shallow. These soils formed in loamy material weathered from calcareous sandstone. The Oglala soil is on ridgetops and the lower side slopes, and the Canyon soil is on shoulders and the upper side slopes. Areas range from 5 to 500 acres in size. They consist of 45 to 60 percent Oglala soil and 25 to 35 percent Canyon soil. These soils are so intermingled or mixed that separating them in mapping is not practical.

Typically, the Oglala soil has a surface layer of grayish brown, friable loam about 12 inches thick. The transitional layer is pale brown, very friable loam about 8 inches thick. The underlying material is white, calcareous loam to a depth of 45 inches. Below this to a depth of more than 60 inches is white, calcareous sandstone. In some places the surface layer is very fine sandy loam. In cultivated areas 10 to 20 percent of this soil is eroded. In these areas erosion has removed all or most of the original surface soil, and tillage has mixed the remaining surface soil with the subsoil. In most places the surface layer is light in color and calcareous.

Typically, the Canyon soil has a surface layer of

dark grayish brown, very friable loam about 6 inches thick. The transitional layer is grayish brown, calcareous, friable loam about 6 inches thick. The underlying material is calcareous, pale brown loam to a depth of 17 inches. Below this to a depth of more than 60 inches is white, fine grained sandstone. In some places the surface layer is very fine sandy loam. In cultivated areas erosion has removed all or most of the original surface soil, and the thickness of the loamy material over the sandstone bedrock has been reduced. In some of these areas sandstone cobbles and stones have been dislodged by tillage equipment and are on the surface. In these areas the surface layer is light in color and calcareous.

Included with these soils in mapping are small areas of Alliance and Rosebud soils. The included soils have more clay in the profile than the Oglala soil. Rosebud soils are moderately deep over calcareous sandstone. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Oglala and Canyon soils. Available water capacity is high in the Oglala soil and very low in the Canyon soil. The organic matter content is moderate in the Oglala soil and moderately low in the Canyon soil. Runoff is medium. The water intake rate is moderate in the Oglala soil. Root development is restricted by the underlying sandstone in the Canyon soil.

Most of these soils support native grasses and are used as rangeland. A small acreage is used as dryland and irrigated farmland.

If dryland farmed, the Oglala soil is suited to small grains, alfalfa, and introduced grasses. Inadequate rainfall in summer generally limits the cultivated crops that can be grown. Water erosion and soil blowing are the principal hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to control soil blowing and water erosion and conserve soil moisture. Returning crop residue to the soil helps to maintain the organic matter content and fertility and improves the water intake rate. Stripcropping, terraces, and annual cover crops also help to control water erosion and soil blowing. Summer fallowing conserves moisture for use during the following growing season. Terraces are generally difficult to construct because of the shallow depth to bedrock in areas of the Canyon soil.

If irrigated by a sprinkler system, the Oglala soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. Soil blowing is the principal hazard. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and water

erosion and conserve soil moisture. The use of winter cover crops also helps to control soil blowing. Incorporating crop residue and green manure crops into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone and result in the hazard of water erosion on the slopes.

The Canyon soil is not suited to dryland farming or irrigation because of the shallow depth to bedrock.

These soils are suited to introduced grasses used as pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. These soils are subject to erosion. Overgrazing or improper haying causes poor plant vigor and loss of production. Overgrazing and improper haying also reduce the amount of protective cover and can result in soil blowing and the formation of small gullies and rills after heavy rains. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

If these soils are used for range or native hay, the climax vegetation on the Oglala soil is dominantly big bluestem, blue grama, little bluestem, sideoats grama, switchgrass, and western wheatgrass. These species make up 70 percent or more of the total annual forage. Buffalograss, needleandthread, prairie junegrass, Scribner panicum, sedges, and forbs make up the rest. The climax vegetation on the Canyon soil is dominantly little bluestem, sideoats grama, western wheatgrass, blue grama, hairy grama, big bluestem, and threadleaf sedge. These species make up 60 percent or more of the total annual forage. Prairie sandreed, needleandthread, green needlegrass, and forbs make up the rest. If subject to continuous heavy grazing, big bluestem, little bluestem, prairie junegrass, and switchgrass decrease in abundance on the Oglala soil, and little bluestem and big bluestem decrease in abundance on the Canyon soil. They are

replaced by blue grama, buffalograss, needleandthread, plains muhly, sand dropseed, tall dropseed, western wheatgrass, and forbs on the Oglala soil and sideoats grama, blue grama, hairy grama, prairie sandreed, sand dropseed, threadleaf sedge, and forbs on the Canyon soil. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive. Woody plants may invade the site on the Canyon soil.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre on the Oglala soil and 0.5 animal unit month per acre on the Canyon soil. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range. In areas where gullies have formed because of severe water erosion, land shaping or other mechanical practices may be needed to smooth and stabilize the site before it is reseeded. Brush management may be needed in some areas to control the woody plants that invade the site.

The Oglala soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and soil erosion are the principal hazards affecting seedlings and young trees. Seedlings can survive and grow if competing vegetation between the tree rows is controlled by cultivation with conventional equipment. The undesirable grasses and weeds in the rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide. Planting an annual cover crop between the rows helps to control erosion. Irrigation can provide supplemental moisture during periods of low rainfall. The Canyon soil is generally not suited to the trees and shrubs planted in windbreaks because of the shallow depth to bedrock and the very low available water capacity. A few areas may be suitable for the trees or shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used.

In areas of the Oglala soil, mounding the sites for septic tank absorption fields with several feet of suitable fill material improves the filtering capacity of the soil. The moderate permeability of this soil is also a limitation affecting septic tank absorption fields, but increasing the size of the absorption field can generally overcome this limitation. Land shaping and installing the absorption field on the contour are

generally necessary for its proper operation. The Canyon soil is generally not suited to sanitary facilities because of the shallow depth to bedrock. A suitable alternative site should be selected. Buildings should be designed so that they conform to the natural slope of the land, or the soils should be graded to a suitable gradient. In areas of the Canyon soil, the soft bedrock can be excavated during the construction of dwellings with basements or buildings that have deep foundations. A good surface drainage system can minimize the damage to roads caused by frost action in areas of the Oglala soil. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. In areas of the Canyon soil, the soft bedrock can be excavated during the construction of roads. Onsite investigation is needed before any engineering practices are applied.

The land capability units are IIIe-1, dryland, and IIe-6, irrigated, for the Oglala soil and VIIs-4, dryland, for the Canyon soil. The Oglala soil is in the Silty range site and windbreak suitability group 3. The Canyon soil is in the Shallow Limy range site and windbreak suitability group 10.

**OhD—Oglala-Canyon complex, 6 to 11 percent slopes.** These strongly sloping, well drained soils are on uplands. The Oglala soil is deep, and the Canyon soil is shallow. These soils formed in loamy material weathered from calcareous sandstone. The Oglala soil is on ridgetops and the lower side slopes, and the Canyon soil is on the upper side slopes. Areas range from 5 to more than 500 acres in size. They consist of 45 to 60 percent Oglala soil and 25 to 35 percent Canyon soil. These soils are so intermingled or mixed that separating them in mapping is not practical.

Typically, the Oglala soil has a surface layer of dark grayish brown, friable loam about 10 inches thick. The transitional layer is brown, very friable loam about 9 inches thick. The underlying material is light gray and white, calcareous loam to a depth of 51 inches. Below this to a depth of more than 60 inches is white, calcareous sandstone. In some places the surface layer is very fine sandy loam. In cultivated areas 15 to 35 percent of this soil is eroded. In these areas erosion has removed all or most of the original surface soil, and tillage has mixed the remaining surface soil with the subsoil. In most places the surface layer is light in color and calcareous.

Typically, the Canyon soil has a surface layer of dark grayish brown, very friable loam about 3 inches thick. The transitional layer is grayish brown, very friable, calcareous loam about 3 inches thick. The underlying material is light gray, calcareous very fine

sandy loam to a depth of 14 inches. Below this to a depth of more than 60 inches is white, calcareous sandstone. In some places the surface layer is fine sandy loam or very fine sandy loam. In other places the dark surface layer is more than 3 inches thick. In cultivated areas erosion has removed all or most of the original surface soil, and the thickness of the loamy material over the sandstone bedrock has been reduced. In some areas sandstone cobbles and stones have been dislodged by tillage equipment and are on the surface. In these areas the surface layer is light in color and calcareous.

Included with these soils in mapping are small areas of Alliance, Rosebud, and Satanta soils. The included soils have more clay in the profile than the Oglala soil and are on similar landscapes. Rosebud soils are moderately deep over calcareous sandstone. Satanta soils do not have bedrock within a depth of 60 inches. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Oglala and Canyon soils. Available water capacity is moderate in the Oglala soil and very low in the Canyon soil. The organic matter content is moderate in the Oglala soil and moderately low in the Canyon soil. Runoff is medium. The water intake rate is moderate. Root development is restricted by the underlying sandstone in the Canyon soil.

Most of these soils support native grasses and are used as range (fig. 13). A small acreage is used as cropland.

If dryland farmed, the Oglala soil is poorly suited to small grains, alfalfa, and introduced grasses. Inadequate rainfall in summer generally limits the cultivated crops that can be grown. Water erosion and soil blowing are the principal hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to control soil blowing and water erosion and conserve soil moisture. Stripcropping, terraces, and annual cover crops also help to control soil blowing and water erosion. Summer fallowing conserves moisture for use during the following growing season. Terraces are generally difficult to construct because of the irregular topography and the shallow depth to bedrock in areas of the Canyon soil.

If irrigated by a sprinkler system, the Oglala soil is poorly suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. Water erosion and soil blowing are the principal hazards on the slopes. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control erosion and conserve soil

moisture. The use of winter cover crops also helps to control soil blowing. Incorporating crop residue and green manure crops into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone and result in the hazard of water erosion on these slopes.

The Canyon soil is not suited to dryland farming or irrigation because of the shallow depth to bedrock.

These soils are poorly suited to introduced grasses used as pasture and hayland. These grasses can be rotated with other crops on the Oglala soil. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. This soil is subject to water erosion. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Continuous heavy grazing and improper haying also reduce the amount of protective cover and can result in soil blowing and the formation of small gullies and rills after heavy rains. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

If these soils are used for range or native hay, the climax vegetation on the Oglala soil is dominantly blue grama, sideoats grama, and western wheatgrass. These species make up 60 percent or more of the total annual forage. Buffalograss, needleandthread, prairie junegrass, Scribner panicum, sedges, and forbs make up the rest. The climax vegetation on the Canyon soil is dominantly little bluestem, sideoats grama, blue grama, hairy grama, big bluestem, and threadleaf sedge. These species make up 70 percent or more of the total annual forage. Prairie sandreed, needleandthread, green needlegrass, and forbs make up the rest. If subject to continuous heavy grazing, big bluestem, little bluestem, prairie junegrass, and switchgrass decrease in abundance on the Oglala soil and little bluestem and big bluestem decrease in abundance on the Canyon soil. They are replaced by blue grama, buffalograss, needleandthread, plains



Figure 13.—A typical area of Oglala-Canyon complex, 6 to 11 percent slopes, that supports native grasses and is used for grazing.

muhly, sand dropseed, tall dropseed, western wheatgrass, and forbs on the Oglala soil and sideoats grama, blue grama, hairy grama, prairie sandreed, sand dropseed, threadleaf sedge, and forbs on the Canyon soil. If overgrazing continues for many years, the native grasses on the Oglala soil lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive. Woody plants may invade the site on the Canyon soil.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre on the Oglala soil and 0.5 animal unit month per acre on the Canyon soil. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range. In areas where gullies have formed because of severe water erosion, land shaping or other mechanical practices may be needed to smooth and stabilize the site before

it is reseeded. Brush management may be needed in some areas to control the woody plants that invade the site.

The Oglala soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate rainfall and soil erosion are the principal hazards affecting seedlings and young trees. Seedlings can survive and grow if competing vegetation between the tree rows is controlled by cultivation with conventional equipment. The undesirable grasses and weeds in the rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide. Planting an annual cover crop between the rows helps to control soil blowing. Irrigation can provide supplemental moisture during periods of low rainfall. The Canyon soil generally is not suited to the trees and shrubs planted in windbreaks because of the shallow depth to bedrock. A few areas may be suitable for the trees or shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used.

In areas of the Oglala soil, mounding the sites for

septic tank absorption fields with several feet of suitable fill material improves the filtering capacity of the soil. The moderate permeability of this soil is also a limitation affecting septic tank absorption fields, but increasing the size of the absorption field can generally overcome this limitation. Land shaping and installing the absorption field on the contour are generally necessary for its proper operation. The Canyon soil is generally not suited to sanitary facilities because of the shallow depth to bedrock. A suitable alternative site should be selected. Buildings should be designed so that they conform to the natural slope of the land, or the soils should be graded to a suitable gradient. In areas of the Canyon soil, the soft bedrock can be excavated during the construction of dwellings with basements or buildings that have deep foundations. The sides of shallow excavations can cave in unless they are shored. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. Cutting and filling can provide a suitable grade for roads. In areas of the Canyon soil, the soft bedrock can be excavated during the construction of roads. Onsite investigation is needed before any engineering practices are applied.

The land capability units are IVe-1, dryland, and IVe-6, irrigated, for the Oglala soil and VIs-4, dryland, for the Canyon soil. The Oglala soil is in the Silty range site and windbreak suitability group 3. The Canyon soil is in the Shallow Limy range site and windbreak suitability group 10.

**OhF—Oglala-Canyon complex, 11 to 30 percent slopes.** These moderately steep and steep, well drained soils are on uplands. The Oglala soil is deep, and the Canyon soil is shallow. These soils formed in loamy material weathered from calcareous sandstone. The Oglala soil is on the lower side slopes, and the Canyon soil is on convex ridgetops and the upper side slopes. Areas range from 50 to 1,000 acres in size. They consist of 40 to 55 percent Oglala soil and 30 to 40 percent Canyon soil. These soils are so intermingled or mixed that separating them in mapping is not practical.

Typically, the Oglala soil has a surface layer of grayish brown, friable loam about 8 inches thick. The transitional layer is grayish brown, friable silt loam about 11 inches thick. The underlying material to a depth of 58 inches is light brownish gray, calcareous silt loam in the upper part and light gray, calcareous loam in the lower part. Below a depth of 58 inches is white, calcareous sandstone. In some places the surface layer is very fine sandy loam. In cultivated

areas 25 to 50 percent of this soil is eroded. In these areas erosion has removed all or most of the original surface soil, and tillage has mixed the remaining surface soil with the subsoil. In most places the surface layer is light in color and calcareous.

Typically, the surface layer of the Canyon soil is grayish brown, very friable loam about 5 inches thick. The transitional layer is light brownish gray, very friable, calcareous very fine sandy loam about 5 inches thick. The underlying material is light gray, calcareous very fine sandy loam to a depth of 14 inches. Below this to a depth of more than 60 inches is white, calcareous sandstone. In places the surface layer is very fine sandy loam or fine sandy loam. In cultivated areas erosion has removed all or most of the original surface soil, and the thickness of the loamy material over the sandstone bedrock has been reduced. In some areas sandstone cobbles and stones have been dislodged by tillage equipment and are on the surface. In these areas the surface layer is light in color and calcareous.

Included with these soils in mapping are small areas of Alliance and Satanta soils. The included soils have more clay in the profile than the Oglala and Canyon soils. These soils are on similar landscapes as the Oglala soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Oglala and Canyon soils. Available water capacity is moderate in the Oglala soil and very low in the Canyon soil. The organic matter content is moderate in the Oglala soil and moderately low in the Canyon soil. Runoff is rapid. Root development is restricted by the underlying sandstone in the Canyon soil.

Nearly all of the acreage of these soils is used as rangeland.

These soils are not suited to farming because of the steep slope and the shallow root zone of the Canyon soil.

If these soils are used for range or native hay, the climax vegetation on the Oglala soil is dominantly blue grama, sideoats grama, and western wheatgrass. These species make up 60 percent or more of the total annual forage. Buffalograss, needleandthread, prairie junegrass, Scribner panicum, sedges, and forbs make up the rest. The climax vegetation on the Canyon soil is dominantly little bluestem, sideoats grama, blue grama, hairy grama, big bluestem, and threadleaf sedge. These species make up 70 percent or more of the total annual forage. Prairie sandreed, needleandthread, green needlegrass, and forbs make up the rest. If subject to continuous heavy grazing, big bluestem, little bluestem, prairie junegrass, and switchgrass decrease in abundance on the Oglala soil

and little bluestem and big bluestem decrease in abundance on the Canyon soil. They are replaced by blue grama, buffalograss, needleandthread, plains muhly, sand dropseed, tall dropseed, western wheatgrass, and forbs on the Oglala soil and sideoats grama, blue grama, hairy grama, prairie sandreed, sand dropseed, threadleaf sedge, and forbs on the Canyon soil. If overgrazing continues for many years, the native grasses on the Oglala soil lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive. Woody plants may invade the site on the Canyon soil.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre on the Oglala soil and 0.5 animal unit month per acre on the Canyon soil. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range. In areas where gullies have formed because of severe water erosion, land shaping or other mechanical practices may be needed to smooth and stabilize the site before it is reseeded. Brush management may be needed in some areas to control the woody plants that invade the site.

The Oglala soil is generally not suited to the trees and shrubs planted in windbreaks because of the slope. The Canyon soil is not suited because of the shallow depth to bedrock. A few areas of these soils may be suitable for the trees or shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used.

These soils are generally not suitable for sanitary facilities because of the steep slope and the shallow depth to bedrock in the Canyon soil. In areas of the Oglala soil, dwellings and buildings need to be properly designed so that they conform to the natural slope of the land, or the soil can be graded to a suitable gradient. The sides of shallow excavations can cave in unless they are shored. The Canyon soil is not suitable for dwellings and buildings because of the shallow depth to bedrock. In areas of the Oglala soil, cutting and filling generally can provide a suitable grade for roads. In areas of the Canyon soil, the bedrock can be excavated during the construction of roads. Onsite investigation is needed before any engineering practices are applied.

The land capability unit is VIe-1, dryland, for the Oglala soil and VIc-4, dryland, for the Canyon soil. The

Oglala soil is in the Silty range site, and the Canyon soil is in the Shallow Limy range site. Both soils are in windbreak suitability group 10.

**On—Onita silty clay loam, 0 to 1 percent slopes.**

This very deep, nearly level, moderately well drained soil is in upland swales. It formed in loamy and clayey sediments. This soil is subject to rare flooding. Areas range from 10 to 200 acres in size.

Typically, the surface layer is dark gray, friable silty clay loam about 8 inches thick. The subsoil is about 43 inches thick. The upper part is very dark gray and dark gray, firm silty clay. The lower part is grayish brown, friable, calcareous silt loam. The underlying material is light brownish gray, calcareous silt loam to a depth of more than 60 inches. In some places the surface layer is silt loam or loam.

Included with this soil in mapping are small areas of Lodgepole soils, which are somewhat poorly drained and are in depressions that are ponded for short periods. Also included are some areas that have a perched water table within a depth of 3 feet during wet periods. Included soils make up about 5 to 15 percent of the unit.

Permeability is slow in the Onita soil. Available water capacity is high, but moisture is released slowly to plants. The organic matter content is moderate. Runoff is slow. This soil has a perched water table that ranges from a depth of 3 to 6 feet in most years. The water intake rate is low.

All of the acreage of this soil is cultivated. Some of the acreage is irrigated.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. This soil dries out slowly in the spring. The surface layer is often saturated in some of the low lying areas or swales in the spring and during wet periods. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Soil blowing is a slight hazard if the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to conserve soil moisture and control soil blowing. Returning crop residue to the soil helps to maintain the organic matter content and fertility and improves the water intake rate.

If irrigated, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. It is suited to sprinkler and gravity irrigation systems. Some land leveling is generally needed for gravity systems to ensure the uniform distribution of water. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil

moisture. Incorporating crop residue into the soil helps to maintain the organic matter content and fertility. All irrigation systems need to be designed so that the water application rate does not exceed the low intake rate of this soil. A tailwater recovery system can be used to conserve water.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants is effective in controlling soil blowing. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain the native plants in good condition.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall is the principal hazard affecting seedlings and young trees. Seedlings can survive and grow if competing vegetation between the tree rows is controlled by cultivation with conventional equipment. The undesirable grasses and weeds in the rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide. Planting an annual cover crop between the tree rows helps to control soil blowing. Irrigation can provide supplemental moisture during periods of low rainfall.

The hazard of rare flooding needs to be considered if this soil is used for sanitary facilities and building sites. Because of the slow permeability, this soil is not suited to septic tank absorption fields. Enlarging the field or installing an alternative system is necessary for its proper operation. Strengthening the foundations for dwellings without basements and backfilling with coarse textured material help to prevent the damage

caused by shrinking and swelling. Roads and streets need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil material. Coarser grained subgrade or base material can be used to ensure better performance. A good surface drainage system can minimize the damage to roads and streets caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. Mixing the base material with additives, such as hydrated lime, help to prevent shrinking and swelling.

The land capability units are IIs-2, dryland, and IIs-3, irrigated; Clayey range site; and windbreak suitability group 1.

**OrF—Orella silty clay loam, 3 to 30 percent slopes.** This shallow, gently sloping to steep, well drained soil is on uplands. It formed in material weathered from shale. Areas range from 20 to 100 acres in size.

Typically, the surface layer is dark grayish brown, firm silty clay loam about 5 inches thick. The transitional layer is light brownish gray, firm, calcareous silty clay loam about 5 inches thick. The underlying material is light gray, calcareous silty clay loam to a depth of 16 inches. Below this to a depth of more than 60 inches is light gray shale. In some places the surface layer is clay loam or silty clay. In other places the transitional layer and underlying material are silty clay or clay.

Included with this soil in mapping are small areas of Bufton and Minnequa soils and areas of Badland. Bufton soils are very deep and are on similar landscapes as the Orella soil. Minnequa soils are moderately deep and formed in material weathered from interbedded chalk and shale. These soils are lower on the landscape than the Orella soil. The areas of Badland are exposed shales and siltstones that are barren and eroded. Included areas make up 5 to 20 percent of the unit.

Permeability is very slow in the Orella soil. Available water capacity is very low. The organic matter content is low. Runoff is rapid.

All of the acreage of this soil supports native grasses and is used for range. This soil is not suited to farming or the trees and shrubs planted in windbreaks because of the high content of sodium and other salts and the shallow depth to shale.

If this soil is used as range, the climax vegetation is dominantly blue grama, buffalograss, inland saltgrass, and western wheatgrass. These species make up 75 percent or more of the total annual production. Sideoats grama, alkali sacaton, grasslike plants, and

forbs make up the rest. If subject to continuous heavy grazing, alkali sacaton and western wheatgrass decrease in abundance.

If the range is in excellent condition, the suggested initial stocking rate is 0.3 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing helps to maintain or improve the range condition. Livestock tend to overuse areas near watering and salting facilities. The areas away from the watering facilities may be underused. Properly locating fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Locating the salting facilities away from the watering facilities and relocating them each time that salt is provided helps to prevent excessive trampling and overuse. Careful management is needed to maintain the plant cover. Proper grazing use is effective in controlling soil blowing and water erosion. The high content of sodium influences the kind of plants that grow and limits forage production on this soil.

This soil is not suited to sanitary facilities because of the steep slope and the depth to shale. A suitable alternative site should be selected. The soft bedrock can be excavated during the construction of dwellings with basements or buildings that have deep foundations. Strengthening the foundations of buildings and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling. Foundations also need to be properly designed so that they conform to the natural slope of the land, or the soil can be graded to a suitable gradient. The soft bedrock can be excavated during the construction of roads. Cutting and filling generally can provide a suitable grade for roads. Roads need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance. Mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The land capability unit is VIs-4, dryland; Saline Upland range site; and windbreak suitability group 10.

**OvD—Orpha loamy fine sand, 3 to 9 percent slopes.** This very deep, gently sloping and strongly sloping, excessively drained soil is on foot slopes along the Niobrara River and its tributaries. It formed in sandy material weathered from sandstone. Areas range from 10 to 100 acres in size.

Typically, the surface layer is grayish brown, very friable loamy fine sand about 6 inches thick. The transitional layer is light brownish gray, loose fine sand about 6 inches thick. The underlying material extends

to a depth of more than 60 inches. It is light brownish gray fine sand in the upper part and white, calcareous fine sand in the lower part. Sandstone gravel is in the underlying material. In a few places this soil is very gently sloping. In a few areas the surface layer is loamy sand or sand.

Included with this soil in mapping are small areas of Dailey, Niobrara, and Valent soils. Dailey soils have a dark surface soil more than 10 inches thick and are lower on the landscape than the Orpha soil. Niobrara soils are shallow over sandstone and are higher on the landscape than the Orpha soil. Valent soils formed in eolian sand and are higher on the landscape than the Orpha soil. Included soils make up 10 to 15 percent of the unit.

Permeability is rapid in the Orpha soil, and available water capacity is low. The organic matter content is low. Runoff is slow. The water intake rate is very high.

Most of the acreage of this soil supports range and is used for grazing. Some areas are used as hayland.

This soil is not suited to dryland farming because it is too droughty and soil blowing is a severe hazard.

If irrigated by a sprinkler system, this soil is poorly suited to corn, alfalfa, and introduced grasses. It is too sandy for gravity irrigation systems. Light, frequent applications of irrigation water are needed because of the low available water capacity of this soil. Soil blowing is a severe hazard in areas where the surface is not protected by crops or crop residue. Establishing crops is a concern because of the hazard of soil blowing. The use of close-growing crops, a system of conservation tillage that keeps crop residue on the surface, and the use of cover crops during the winter help to control soil blowing. Incorporating crop residue into the soil improves the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone.

If this soil is used as range or hayland, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, and needleandthread. These species make up 75 percent or more of the total annual forage. Blue grama, switchgrass, sand lovegrass, sedges, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, blue grama, sand dropseed, sedges, and forbs. If heavy grazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, soil blowing is excessive and blowouts can form.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A

planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy.

This soil is suited to the trees and shrubs planted in windbreaks. Soil blowing is a severe hazard affecting the establishment of windbreaks. It can be controlled by planting the seedlings in a shallow furrow with as little disturbance of the soil as possible. Strips of sod or cover crops also need to be maintained between the tree rows. Insufficient rainfall in summer is another limitation affecting the survival of young trees. Irrigation can provide supplemental moisture during periods of low rainfall. The weeds and undesirable grasses in the tree rows can be controlled by careful use of the appropriate kind of herbicide or by hoeing by hand.

This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in pollution of the ground water. This soil is generally suited to dwellings and roads. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. The sides of shallow excavations can cave in unless they are shored. Seeding the roadside after construction helps to stabilize the loose soil.

The land capability units are VIe-5, dryland, and IVe-11, irrigated; Sands range site; and windbreak suitability group 7.

**OwF—Orpha-Niobrara complex, 9 to 30 percent slopes.** These strongly sloping to steep, excessively drained soils are on valley side slopes along the Niobrara River and its tributaries. The Orpha soil is very deep, and the Niobrara soil is shallow. These soils formed in sandy material weathered from sandstone. Areas range from 100 to 1,000 acres in size. They are 55 to 75 percent Orpha soil and 25 to 45 percent Niobrara soil. They are so intermingled or mixed that separating them in mapping is not practical.

Typically, the Orpha soil has a surface layer of grayish brown, loose loamy fine sand about 6 inches thick. The transitional layer is light brownish gray, loose

fine sand about 5 inches thick. The underlying material extends to a depth of more than 60 inches. It is pale brown fine sand in the upper part and pale brown, calcareous fine sand in the lower part. Sandstone gravel are throughout the profile. In places the surface layer is loamy sand or sand. In some areas the profile is calcareous throughout.

Typically, the Niobrara soil has a surface layer of light brownish gray, very friable, calcareous loamy fine sand about 4 inches thick. The underlying material to a depth of 13 inches is light brownish gray, calcareous fine sand. Below this to a depth of more than 60 inches is white, calcareous sandstone. In places the surface layer is fine sandy loam or fine sand.

Included soils make up 5 to 25 percent of the unit.

Permeability is rapid in the Orpha and Niobrara soils. Available water capacity is low in the Orpha soil and very low in the Niobrara soil. The organic matter content is low in both soils. Runoff is slow and medium.

All of the acreage of these soils is used for range.

These soils are too steep and droughty for use as cropland. The Niobrara soil is also shallow to bedrock. Soil blowing is a severe hazard.

If these soils are used for range or native hay, the climax vegetation on the Orpha soil is dominantly prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 75 percent or more of the total annual forage. Blue grama, switchgrass, sand lovegrass, sedges, and forbs make up the rest. The climax vegetation on the Niobrara soil is dominantly prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 75 percent or more of the total annual forage. Blue grama, switchgrass, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance on the Orpha soil and little bluestem and switchgrass decrease in abundance on the Niobrara soil. They are replaced by needleandthread, blue grama, sand dropseed, sedges, and forbs on the Orpha soil and sideoats grama, blue grama, hairy grama, prairie sandreed, sand dropseed, threadleaf sedge, and forbs on the Niobrara soil. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, soil blowing is excessive and small blowouts can form. Woody plants may invade the site on the Niobrara soil.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre on the Orpha soil and 0.5 animal unit month per acre on the Niobrara soil. The stocking rate is determined by the percentage of each soil in the pasture. The

range should be closely monitored during use and the stocking rates adjusted so that one soil does not become overgrazed. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Brush management may be needed in some areas to control the woody plants that invade the site. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

These soils are generally not suited to the trees and shrubs planted in windbreaks because of the slope and the shallow depth to bedrock in the Niobrara soil. A few areas may be suitable for the trees and shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used.

These soils are generally not suited to sanitary facilities because of the slope and the poor filtering capacity in areas of the Orpha soil and the shallow depth to bedrock in areas of the Niobrara soil. A suitable alternative site should be selected. Dwellings and buildings need to be properly designed so that they conform to the natural slope of the land, or the soils can be graded to a suitable gradient. In areas of the Niobrara soil, the soft bedrock can be excavated during the construction of dwellings with basements or buildings that have deep foundations. The sides of shallow excavations in this soil can cave in unless they are shored. Cutting and filling generally can provide a suitable grade for roads. The soft bedrock can be excavated during the construction of roads in areas of the Niobrara soil. Onsite investigation is needed before any engineering practices are applied.

The land capability unit is V1e-5, dryland, for the Orpha soil and V1s-4, dryland, for the Niobrara soil. The Orpha soil is in the Sands range site, and the Niobrara soil is in the Shallow Limy range site. Both soils are in windbreak suitability group 10.

**OxG—Orpha-Rock outcrop complex, 20 to 60 percent slopes.** This complex consists of the steep and very steep, excessively drained Orpha soil and areas of Rock outcrop. It is along the breaks to the Niobrara River and its tributaries. The Orpha soil is very deep and formed in sandy material weathered from sandstone. It is dominantly on the mid and lower side slopes. The areas of Rock outcrop are on ridges, knolls, and the upper side slopes. Areas range from 100 to 1,000 acres in size. They consist of 60 to 85 percent Orpha soil and 10 to 20 percent areas of Rock

outcrop. These areas are so intermingled or mixed that separating them in mapping is not practical.

Typically, the Orpha soil has a surface layer of grayish brown, very friable loamy fine sand about 6 inches thick. The transitional layer is light brownish gray, loose sand about 4 inches thick. The underlying material is light gray sand and fine sand to a depth of 60 inches or more. The lower part is calcareous. Sandstone gravel is throughout the underlying material. In some places the surface layer is loamy sand. In other places the surface layer is dark and more than 10 inches thick. In a few areas the profile is calcareous throughout. In other places calcareous sandstone is within a depth of 60 inches.

Typically, the areas of Rock outcrop consist of light gray and white, calcareous sandstone. In some places soil material that is 1 to 10 inches thick is on the sandstone.

Included with this unit in mapping are small areas of Niobrara soils, which have sandstone at a depth of 10 to 20 inches and are on similar landscapes as the Orpha soil and the areas of Rock outcrop. Also included are areas that have strata of very gravelly sand to very gravelly fine sandy loam in the profile. Included areas make up 10 to 25 percent of the unit.

Permeability is rapid in the Orpha soil, and available water capacity is low. The organic matter content is low. Runoff is medium.

All of the acreage in this map unit is used for range. Ponderosa pine is in some areas along the Niobrara River. Stands of deciduous trees are along some of the other streams and drainageways.

This map unit is not suited to farming because of the steep slope and the areas of Rock outcrop.

If this map unit is used for range, the climax vegetation on the Orpha soil is dominantly sand bluestem, little bluestem, prairie sandreed, and needleandthread. These species make up 75 percent or more of the total annual forage. Blue grama, switchgrass, sand lovegrass, sedges, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, blue grama, sand dropseed, sedges, and forbs. If heavy grazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, soil blowing is excessive and blowouts can form.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition.

Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. The slope can hinder the movement of livestock. Brush management may be needed in some areas to control the woody plants that invade the site.

The Orpha soil generally is not suited to the trees and shrubs planted in windbreaks because of the steep and very steep slopes and the rock outcrop. A few areas may be suitable for the trees and shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used.

The Orpha soil is generally not suitable for sanitary facilities because of the slope and the areas of Rock outcrop. A suitable alternative site should be selected. Dwellings and buildings need to be properly designed so that they conform to the natural slope of the land. Also, the bedrock can be excavated during the construction of dwellings with basements or buildings that have deep foundations in the areas of Rock outcrop. The sides of shallow excavations in the Orpha soil can cave in unless they are shored. Cutting and filling generally can provide a suitable grade for roads. The bedrock can be excavated during the construction of roads in the areas of Rock outcrop.

The land capability unit is VIIe-5, dryland, for the Orpha soil and VIIIs-8, dryland, for the areas of Rock outcrop. The Orpha soil is in the Sands range site. No range site is assigned to the areas of Rock outcrop. The Orpha soil and the areas of Rock outcrop are in windbreak suitability group 10.

**PoC—Ponderosa very fine sandy loam, 3 to 6 percent slopes.** This very deep, gently sloping, well drained soil is on foot slopes in the Pine Ridge. It formed in sandy and loamy sediments weathered from calcareous sandstone. Areas range from 5 to 100 acres in size.

Typically, the surface layer is grayish brown, very friable very fine sandy loam about 8 inches thick. The subsurface layer is also grayish brown, very friable very fine sandy loam about 10 inches thick. The transitional layer is light brownish gray, very friable very fine sandy loam about 12 inches thick. The underlying material is very pale brown, calcareous very fine sandy loam and loamy very fine sand to a depth of 60 inches or more. In some places the surface layer is loamy very fine sand. In other places carbonates are within a depth of 15 inches.

Included with this soil in mapping are small areas of Bridget soils, which have less sand than the Ponderosa soil and are lower on the landscape. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Ponderosa soil, and available water capacity is high. The organic matter content is moderately low. Runoff is medium. The water intake rate is moderately high.

Most of the acreage of this soil is used as range. Some areas are used as cropland.

If dryland farmed, this soil is suited to small grains, alfalfa, and introduced grasses. Inadequate rainfall in summer generally limits the cultivated crops that can be grown. Water erosion and soil blowing are hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to control soil blowing and water erosion and conserve soil moisture. Stripcropping, terraces, and annual cover crops help to control erosion. Summer fallowing conserves moisture for use during the following growing season.

If irrigated, this soil is suited to small grains, alfalfa, and introduced grasses. It is best suited to sprinkler irrigation systems because of the moderately high water intake rate. Extensive land leveling is generally needed if gravity systems are used to ensure the uniform distribution of water; however, care should be taken not to expose the sandy underlying material. Soil blowing and water erosion are the principal hazards. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. The use of winter cover crops also helps to control soil blowing. Incorporating crop residue and green manure crops into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone and result in the hazard of water erosion on these slopes.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Continuous heavy grazing and improper haying also reduce the protective cover and can result in soil blowing and the formation of small gullies and rills after heavy rains. Managing separate pastures of cool- and warm-season grasses can extend the grazing

season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil blowing and water erosion. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. As a result, soil blowing and water erosion are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs planted in windbreaks. Soil blowing and water erosion are hazards. Erosion can be controlled by maintaining strips of sod or a cover crop between the tree rows. The weeds and undesirable grasses in the rows can be controlled by careful use of the appropriate kind of herbicide or by hoeing by hand. Cultivation between the tree rows with conventional equipment can control undesirable grasses and weeds in areas where strips of sod and cover crops are not used. The lack of adequate rainfall in summer is also a hazard affecting the survival of young trees. Irrigation can provide supplemental moisture during periods of low rainfall.

This soil is generally suitable for septic tank absorption fields and roads. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. The sides of shallow excavations can cave in unless they are shored.

The land capability units are Ille-3, dryland, and Ille-8, irrigated; Sandy range site; and windbreak suitability group 5.

**PoD—Ponderosa very fine sandy loam, 6 to 9 percent slopes.** This very deep, strongly sloping, well drained soil is on valley sides and foot slopes in the Pine Ridge. It formed in sandy and loamy sediments weathered from calcareous sandstone. Areas range from 10 to 200 acres in size.

Typically, the surface layer is dark grayish brown, very friable very fine sandy loam about 5 inches thick. The subsurface layer is dark gray, very friable very fine sandy loam about 5 inches thick. The transitional layer is grayish brown, very friable very fine sandy loam about 7 inches thick. The underlying material to a depth of more than 60 inches is loamy very fine sand.

The upper part is light brownish gray, and the lower part is light gray and calcareous. In some places the dark surface soil is more than 20 inches thick. In other places the carbonates are within a depth of 15 inches.

Included with this soil in mapping are small areas of Bridget and Tassel soils. Bridget soils have less sand than the Ponderosa soil and are lower on the landscape. Tassel soils are shallow over sandstone and are higher on the landscape than the Ponderosa soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Ponderosa soil, and available water capacity is high. The organic matter content is moderately low. Runoff is medium. The water intake rate is moderately high.

Most of the acreage of this soil supports range. Some areas are used as cropland.

If dryland farmed, this soil is poorly suited to small grains, alfalfa, and introduced grasses. Inadequate rainfall in summer generally limits the crops that can be grown. Water erosion and soil blowing are hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and stripcropping, helps to control soil blowing and water erosion and conserve soil moisture. Incorporating crop residue into the soil helps improve the organic matter content and fertility.

If irrigated by a sprinkler system, this soil is poorly suited to corn, small grains, alfalfa, and introduced grasses. It is too steep for gravity irrigation systems. This soil is best suited to sprinkler systems because of the moderately high water intake rate and the strong slope. Soil blowing and water erosion are severe hazards in areas where the surface is not protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and no-till, that keeps crop residue on the surface helps to control erosion and conserve moisture. Returning crop residue and green manure crops to the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water result in the hazard of water erosion on these slopes and leach plant nutrients below the root zone.

If this soil is used for range or native hay, the climax vegetation is dominantly prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 65 percent or more of the total annual forage. Blue grama, switchgrass, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, prairie sandreed, blue grama, Scribner panicum, sand dropseed, and forbs. If heavy

grazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

This soil is suited to the trees and shrubs planted in windbreaks. Water erosion and soil blowing are hazards. Erosion can be controlled by maintaining strips of sod or a cover crop between the tree rows. The weeds and undesirable grasses in the rows can be controlled by careful use of the appropriate kind of herbicide or by hoeing by hand. Irrigation can provide supplemental moisture during periods of low rainfall.

This soil is generally suited to sites for septic tank absorption fields and roads and streets. Dwellings and buildings need to be properly designed so that they conform to the natural slope of the land, or the soil can be graded to a suitable gradient. The sides of shallow excavations can cave in unless they are shored.

The land capability units are IVe-3, dryland, and IVe-8, irrigated; Sandy range site; and windbreak suitability group 5.

**PtF—Ponderosa-Tassel-Vetal complex, 6 to 30 percent slopes.** These strongly sloping to steep, well drained soils are in the Pine Ridge. They formed in loamy and sandy sediments mainly weathered from sandstone. The very deep Ponderosa soil is on the middle and lower side slopes. The shallow Tassel soil is on ridgetops and the steep upper side slopes. The very deep Vetal soil is on foot slopes and in swales. Areas range from 20 to 500 acres in size. They consist of 20 to 35 percent Ponderosa soil, 15 to 30 percent Tassel soil, 15 to 25 percent Vetal soil, and 25 to 35 percent included soils. They are so intermingled or mixed that separating them in mapping is not practical.

Typically, the Ponderosa soil has a surface layer of grayish brown, very friable very fine sandy loam about 12 inches thick. The transitional layer is pale brown, very friable very fine sandy loam about 9 inches thick. The underlying material extends to a depth of more than 60 inches. It is light brownish gray very fine sandy loam in the upper part and very pale brown, calcareous loamy very fine sand in the lower part. The profile contains less than 15 percent, by volume, sandstone gravel. In some places the surface layer is

loamy very fine sand. In other places calcareous sandstone is at a depth of 40 to 60 inches. In some areas carbonates are at the surface.

Typically, the Tassel soil has a surface layer of grayish brown, very friable, calcareous very fine sandy loam about 3 inches thick. The transitional layer is grayish brown, very friable, calcareous very fine sandy loam about 3 inches thick. The underlying material is pale brown, calcareous very fine sandy loam to a depth of 15 inches. Below this to a depth of more than 60 inches is white, calcareous sandstone. In some places the solum is fine sandy loam or loam.

Typically, the Vetal soil has a surface layer of dark gray, very friable very fine sandy loam about 7 inches thick. The subsurface layer is dark gray, very friable fine sandy loam about 10 inches thick. The transitional layer is very friable fine sandy loam about 25 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. The underlying material is light gray, calcareous fine sand to a depth of 60 inches or more.

Included with these soils in mapping are small areas of Bridget, Busher, and Oglala soils and areas of rock outcrop. Bridget and Oglala soils have more silt and less sand than the Ponderosa, Tassel, and Vetal soils. Bridget soils are on the lower side slopes and toeslopes. Oglala and Busher soils have sandstone at a depth of 40 to 60 inches and are on similar landscapes as the Ponderosa, Tassel, and Vetal soils. The areas of rock outcrop are on ridgetops and steep side slopes. Included soils make up 5 to 25 percent of the unit.

Permeability is moderately rapid in the Ponderosa, Tassel, and Vetal soils. Available water capacity is high in the Ponderosa and Vetal soils and very low in the Tassel soil. The organic matter content is moderately low in all three soils. Runoff is medium and rapid.

Nearly all of the acreage of this complex supports native grasses and is used as range. A few areas that were previously used as cropland have been reseeded to grasses.

These soils are generally not suited to cultivation because of the steep slope and the shallow depth to bedrock in the Tassel soil. Onsite investigation may identify small, isolated areas on the lesser slopes that are suited to alfalfa or small grains.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre on the Ponderosa and Vetal soils and 0.5 animal unit month per acre on the Tassel soil. The stocking rate is determined by the percentage of each soil in the pasture. The range should be closely monitored during use and the stocking rates adjusted so that one soil does not become overgrazed. A planned grazing system that includes proper grazing use and timely

deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Brush management may be needed in some areas to control the woody plants that invade the site. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If these soils are used for range or as hayland, the climax vegetation on the Ponderosa soil is dominantly little bluestem, sand bluestem, needleandthread, and switchgrass. These species make up 65 percent or more of the total annual forage. Blue grama, green needlegrass, prairie sandreed, bluegrass, and forbs make up the rest. The climax vegetation on the Tassel soil is dominantly little bluestem, blue grama, needleandthread, and sand bluestem. These species make up 75 percent or more of the total annual forage. Prairie sandreed, threadleaf sedge, and forbs make up the rest. The climax vegetation on the Vetal soil is dominantly prairie sandreed, little bluestem, switchgrass, needleandthread, and sand bluestem. These species make up 75 percent or more of the total annual forage. Blue grama, western wheatgrass, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance on the Ponderosa soil, little bluestem and sand bluestem decrease in abundance on the Tassel soil, and little bluestem, switchgrass, and sand bluestem decrease in abundance on the Vetal soil. They are replaced by needleandthread, blue grama, Scribner panicum, sand dropseed, and forbs on the Ponderosa and Vetal soils and sideoats grama, blue grama, hairy grama, prairie sandreed, sand dropseed, threadleaf sedge, and forbs on the Tassel soil. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive. Woody plants may invade the site on the Tassel soil.

The areas of the Ponderosa and Tassel soils in this complex are generally not suited to the trees and shrubs planted in windbreaks because of the steep slope and the shallow depth to bedrock in areas of the Tassel soil. These areas can be used for the trees and shrubs that enhance recreational areas and wildlife habitat or for forestation if they are planted by hand or if other approved special management is used. The Vetal soil is suited to the trees and shrubs planted in windbreaks. Soil blowing can be controlled by maintaining strips of sod or cover crops between the tree rows. Supplemental water may be needed during dry periods. The weeds and undesirable grasses in the

tree rows can be controlled by proper applications of the appropriate kind of herbicide or by hoeing by hand.

The Ponderosa and Tassel soils are generally not suitable for sanitary facilities because of the strongly sloping and steep slopes and the shallow depth to bedrock in areas of the Tassel soil. In areas of the Vetal soil, land shaping and installing the absorption field on the contour helps to ensure that the system operates properly. Dwellings need to be properly designed so that they conform to the natural slope of the land, or the soil can be graded to a suitable gradient. In areas of the Tassel soil, the soft bedrock can be excavated during the construction of dwellings with basements or buildings that have deep foundations. The sides of shallow excavations in the Ponderosa and Vetal soils can cave in unless they are shored. Cutting and filling generally can provide a suitable grade for roads. The soft bedrock can be excavated during the construction of roads in areas of the Tassel soil. In areas of the Vetal soil a good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. Onsite investigation is needed before any engineering practices are applied.

The land capability unit is V1e-3, dryland, for the Ponderosa and Vetal soils and V1s-4, dryland, for the Tassel soil. The Ponderosa and Vetal soils are in the Sandy range site, and the Tassel soil is in the Shallow Limy range site. The Ponderosa and Tassel soils are in windbreak suitability group 10. The Vetal soil is in windbreak suitability group 5.

**RoB—Rosebud loam, 1 to 3 percent slopes.** This moderately deep, very gently sloping, well drained soil is on uplands. It formed in loamy material weathered from calcareous sandstone. Areas range from 5 to 200 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 9 inches thick. The subsoil is about 12 inches thick. The upper part is grayish brown, firm clay loam, and the lower part is very pale brown, very friable, calcareous loam. The underlying material is very pale brown, calcareous loam to a depth of 32 inches. Below this to a depth of more than 60 inches is white, calcareous sandstone. In some places the surface layer is silt loam. In other places the subsoil is silty clay loam or sandy clay loam.

Included with this soil in mapping are small areas of Alliance, Canyon, Duroc, and Oglala soils. Alliance soils have sandstone at a depth of 40 to 60 inches and are on similar landscapes as the Rosebud soil. Canyon soils have sandstone at a depth of 6 to 20

inches and are higher on the landscape than the Rosebud soil. Duroc soils are very deep and have a dark surface soil more than 20 inches thick. These soils are lower on the landscape than the Rosebud soil. Oglala soils have less clay in the profile than the Rosebud soil and have sandstone at a depth of 40 to 60 inches. These soils are on similar landscapes. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Rosebud soil, and available water capacity is low. The organic matter content is moderate. Runoff is slow. The water intake rate is moderate.

Most of the acreage of this soil is dryland farmed. Some areas are irrigated. A few areas support native grasses and are used for grazing.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Soil blowing and water erosion are slight hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to control soil blowing and water erosion and conserve soil moisture. Returning crop residue to the soil helps to maintain the organic matter content and fertility and improve the water intake rate.

If irrigated, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. It is suited to sprinkler and gravity irrigation systems. Some land leveling is generally needed for gravity systems to ensure the uniform distribution of water. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and water erosion and conserve soil moisture. The use of winter cover crops also helps to control soil blowing. Incorporating crop residue into the soil helps to maintain the organic matter content and fertility. Irrigation systems need to be designed so that the water application rate does not exceed the moderate intake rate of this soil. A tailwater recovery system can be used to conserve water.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. Continuous heavy grazing or improper haying causes

poor plant vigor and reduced forage production. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants very effectively controls soil blowing. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants.

This soil is suited to the trees and shrubs planted in windbreaks. The limited rooting depth of this soil and the lack of seasonal rainfall are the main concerns. Soil blowing and water erosion are slight hazards. Irrigation can provide supplemental moisture during periods of low rainfall. Seedlings can survive and grow if competing vegetation between the tree rows is controlled by cultivation with conventional equipment. The undesirable grasses and weeds in the rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide.

The use of this soil for septic tank absorption fields is limited by depth to bedrock. Mounding the site with several feet of suitable fill material improves the filtering capacity of the soil. This soil is generally suited to sites for dwellings without basements. The soft bedrock can be excavated during the construction of dwellings with basements or buildings that have deep foundations. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

The land capability units are Ille-1, dryland, and Ille-4, irrigated; Silty range site; and windbreak suitability group 6R.

**SnB—Satanta fine sandy loam, 0 to 3 percent slopes.** This very deep, nearly level and very gently sloping, well drained soil is on uplands. It formed in loamy eolian material. Areas range from 5 to 140 acres in size.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 9 inches thick. The subsurface layer is dark grayish brown, very friable fine sandy loam about 5 inches thick. The subsoil is

about 21 inches thick. The upper part is grayish brown and pale brown, firm sandy clay loam, and the lower part is light gray, friable, calcareous loam. The underlying material is light gray, calcareous very fine sandy loam and fine sandy loam to a depth of 60 inches or more. In some places the surface layer is loamy sand. In places the dark surface soil is more than 20 inches thick. In a few areas calcareous sandstone or fine sand is below a depth of 40 inches.

Included with this soil in mapping are small areas of Busher, Dailey, and Jayem soils. The included soils have more sand in the profile than the Satanta soil and are on similar landscapes. Busher soils have sandstone at a depth of 40 to 60 inches. Included soils make up 10 to 15 percent of the unit.

Permeability and available water capacity are moderate in the Satanta soil. The organic matter content is moderately low. Runoff is slow. The water intake rate is moderate.

Most of the acreage of this soil is dryland farmed. The rest is used for range.

If dryland farmed, this soil is suited to small grains, alfalfa, and introduced grasses. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Soil blowing and water erosion are slight hazards in areas where the surface is not protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to conserve soil moisture and control erosion. The use of cover crops during the winter also helps to control erosion. Returning crop residue to the soil helps to maintain the organic matter content and fertility and improve the water intake rate.

If irrigated, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. It is suited to sprinkler and gravity irrigation systems. Some land leveling is generally needed for gravity systems to ensure the uniform distribution of water. Soil blowing and water erosion are slight hazards. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and water erosion and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue and green manure crops into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season

grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler or gravity systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil blowing and water erosion. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate rainfall in summer is a hazard affecting the survival of young trees. Supplemental water can provide needed moisture during dry periods. Soil blowing and water erosion are slight hazards. Erosion can be controlled by maintaining strips of sod or a cover crop between the tree rows. The weeds and undesirable grasses in the rows can be controlled by the careful use of the appropriate kind of herbicide or hoeing by hand. Cultivation with conventional equipment between the tree rows can control the undesirable grasses and weeds in areas where strips of sod and cover crops are not used.

The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. Strengthening the foundations of buildings and basements and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling. The sides of shallow excavations can cave in unless they are shored. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance. Mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The land capability units are Ille-3, dryland, and Ile-5, irrigated; Silty range site; and windbreak suitability group 5.

**SnC—Satanta fine sandy loam, 3 to 6 percent slopes.** This very deep, gently sloping, well drained soil is on side slopes and ridges on uplands. It formed in loamy eolian material. Areas range from 5 to 200 acres in size.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 9 inches thick. The subsoil is about 29 inches thick. The upper part is dark grayish brown, friable loam; the middle part is grayish brown, firm clay loam; and the lower part is light gray, friable, calcareous loam. The underlying material is light gray, calcareous very fine sandy loam to a depth of 60 inches or more. In cultivated areas 15 to 30 percent of this soil is eroded. In these areas erosion has removed all or most of the original surface soil, and tillage has mixed the remaining surface soil with the subsoil. In some places the surface layer is light in color and calcareous. In other places the surface layer is clay loam. In other places the surface layer is loamy fine sand. In some areas calcareous sandstone or fine sand is below a depth of 40 inches.

Included with this soil in mapping are small areas of Busher, Dailey, and Jayem soils on similar landscapes as the Satanta soil. The included soils have more sand in the profile. Busher soils have sandstone at a depth of 40 to 60 inches. Included soils make up 10 to 15 percent of the unit.

Permeability and available water capacity are moderate in the Satanta soil. The organic matter content is moderately low. Runoff is slow. The water intake rate is moderate.

Most of the acreage of this soil is dryland farmed. A small acreage is irrigated. The rest is used for range.

If dryland farmed, this soil is suited to small grains, alfalfa, and introduced grasses. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Water erosion and soil blowing are hazards in areas where the surface is not protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to conserve soil moisture and control water erosion and soil blowing. The use of winter cover crops helps to control soil blowing. Terraces and contour farming are effective in controlling water erosion and conserving soil moisture. Returning crop residue to the soil helps to maintain the organic matter content and fertility and improve the water intake rate.

If irrigated by a sprinkler system, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. Extensive land leveling is

generally needed for gravity irrigation systems on this soil. Water erosion and soil blowing are the principal hazards. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control erosion and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone and result in water erosion on the slopes.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. This soil is subject to water erosion. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Continuous heavy grazing and improper haying also reduces the amount of protective cover and can result in soil blowing and the formation of small gullies and rills after heavy rains. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil blowing and water erosion. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. As a result, soil blowing and water erosion are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate rainfall in summer is a hazard affecting the survival of young trees. Supplemental water can provide needed moisture during dry periods. Soil blowing and water erosion are hazards. Erosion can be controlled by maintaining

strips of sod or a cover crop between the tree rows. Cultivation with conventional equipment between the rows can control undesirable grasses and weeds in areas where strips of sod and cover crops are not used. The weeds and undesirable grasses in the tree rows can be controlled by the careful use of the appropriate kind of herbicide or hoeing by hand.

The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. Strengthening the foundations of buildings and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. The sides of shallow excavations can cave in unless they are shored. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance. Mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The land capability units are Ille-3, dryland, and Ille-5, irrigated; Silty range site; and windbreak suitability group 5.

**SnD—Satanta fine sandy loam, 6 to 11 percent slopes.** This very deep, strongly sloping, well drained soil is on side slopes and ridges on uplands. It formed in loamy eolian material. Areas range from 5 to 100 acres in size.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 8 inches thick. The subsurface layer is dark brown, very friable fine sandy loam about 3 inches thick. The subsoil is about 27 inches thick. The upper part is grayish brown, firm clay loam, and the lower part is light gray, friable, calcareous loam. The underlying material is calcareous and extends to a depth of 60 inches or more. It is light gray very fine sandy loam in the upper part and pale brown loamy fine sand in the lower part. In cultivated areas 20 to 35 percent of this soil is eroded. In these areas erosion has removed all or most of the original surface soil, and tillage has mixed the remaining surface soil with the subsoil. In most places the surface layer is light in color and calcareous. In some places the surface layer is clay loam. In a few places the surface layer is loamy fine sand. In some areas calcareous sandstone or fine sand is below a depth of 40 inches.

Included with this soil in mapping are small areas of Busher, Dailey, and Jayem soils. The included soils

have more sand in the profile than the Satanta soil and are on similar landscapes. Busher soils have sandstone at a depth of 40 to 60 inches. Included soils make up 10 to 15 percent of the unit.

Permeability and available water capacity are moderate in the Satanta soil. The organic matter content is moderately low. Runoff is medium. The water intake rate is moderate.

Most of the acreage of this soil is used as range. The rest is dryland farmed.

If dryland farmed, this soil is poorly suited to small grains, alfalfa, and introduced grasses. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Water erosion and soil blowing are the principal hazards in areas where the soil surface is not protected by crops or crop residue. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. Stripcropping, terraces, and annual cover crops help to control water erosion and soil blowing. Returning crop residue to the soil improves the organic matter content and fertility.

If irrigated by a sprinkler system, this soil is poorly suited to corn, field beans, small grains, alfalfa, and introduced grasses. It is not suited to gravity irrigation because of the slope. Water erosion and soil blowing are severe hazards in areas where the surface is not protected by crops or crop residue. Wheel-track erosion can be a management concern if a center-pivot irrigation system is used. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control water erosion and soil blowing and conserve soil moisture. Stripcropping, terraces, and annual cover crops also help to control erosion. Returning crop residue to the soil helps improve the organic matter content and fertility. The irrigation system needs to be designed so that the water application rate does not exceed the moderate water intake rate.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be alternated with other crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. This soil is subject to water erosion. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Continuous heavy grazing and improper haying also reduces the amount

of protective cover and can result in soil blowing and the formation of small gullies and rills after heavy rains. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil blowing and water erosion. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and soil erosion are the main hazards affecting young trees. Supplemental water can provide needed moisture during dry periods. Water erosion and soil blowing can be controlled by maintaining strips of sod or a cover crop between the tree rows. Cultivation with conventional equipment between the rows can control the undesirable grasses and weeds in areas where strips of sod and cover crops are not used. The weeds and undesirable grasses in the tree rows can be controlled by the careful use of the appropriate kind of herbicide or hoeing by hand.

The moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. Land shaping and installing the distribution lines on the contour help to ensure that the absorption field functions properly. Dwellings and buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. Strengthening the foundations of buildings and backfilling with coarse material help to prevent the damage caused by shrinking and swelling. The sides of shallow excavations can cave in unless they are shored. Roads built on this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance. Mixing the base material with additives, such as hydrated lime, helps to prevent

excessive shrinking and swelling. Cutting and filling can provide a suitable grade for roads.

The land capability units are IVe-3, dryland, and IVe-5, irrigated; Silty range site; and windbreak suitability group 5.

**SsD—Satanta-Canyon complex, 6 to 11 percent slopes.** These strongly sloping, well drained soils are on uplands. The very deep Satanta soil formed in loamy eolian material, and the shallow Canyon soil formed in loamy material weathered from calcareous sandstone. The Satanta soil is on the mid and lower side slopes. The Canyon soil is on ridgetops and knolls. Areas range from 15 to 700 acres in size. They consist of about 45 to 60 percent Satanta soil and about 25 to 40 percent Canyon soil. These soils are so intermingled or mixed that separating them in mapping is not practical.

Typically, the surface layer of the Satanta soil is dark grayish brown, very friable fine sandy loam about 10 inches thick. The subsoil is about 23 inches thick. It is grayish brown, firm sandy clay loam in the upper part and pale brown, friable, calcareous loam in the lower part. The underlying material is light gray, calcareous very fine sandy loam to a depth of more than 60 inches. In cultivated areas 20 to 35 percent of this soil is eroded. In these areas erosion has removed all or most of the original surface soil, and tillage has mixed the remaining surface soil with the subsoil. In most places the surface layer is light in color and calcareous. In some places the surface layer is sandy clay loam, clay loam, or loam.

Typically, the surface layer of the Canyon soil is dark grayish brown, very friable, calcareous loam about 6 inches thick. The underlying material is light brownish gray, calcareous loam about 8 inches thick. Calcareous sandstone is at a depth of 14 inches. In cultivated areas erosion has removed all or most of the original surface soil, and the thickness of the loamy material over the sandstone bedrock has been reduced. In these areas numerous sandstone fragments have been dislodged by tillage equipment and are on the surface. In these areas the surface layer is light in color and calcareous. In some places the surface layer is very fine sandy loam or fine sandy loam.

Included with these soils in mapping are small areas of Alliance, Duroc, McCook, and Rosebud soils. Alliance soils have less sand than the Satanta and Canyon soils and are on similar landscapes. Duroc soils have a dark surface soil more than 20 inches thick and are in swales. McCook soils are stratified and are on bottom land. Rosebud soils have

sandstone at a depth of 20 to 40 inches and are on knolls and the upper side slopes. Included soils make up about 5 to 15 percent of the unit.

Permeability is moderate in the Satanta and Canyon soils. Available water capacity is moderate in the Satanta soil and very low in the Canyon soil. Organic matter content is moderately low in both soils. Runoff is medium. The water intake rate is moderate in the Satanta soil.

Most of the acreage of these soils is used as rangeland. A small acreage is used for cultivated crops.

The Canyon soil is not suited to cultivated crops because of the shallow depth to bedrock.

If dryland farmed, the Satanta soil is poorly suited to small grains, alfalfa, and introduced grasses. Inadequate rainfall in summer generally limits the cultivated crops that can be grown. Water erosion and soil blowing are hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as ecofallow, no-till, terraces, stripcropping, and annual cover crops, helps to conserve soil moisture and control erosion.

If irrigated by a sprinkler system, the Satanta soil is poorly suited to corn, field beans, small grains, alfalfa, and introduced grasses. This soil is not suited to gravity irrigation because of the slope. Water erosion and soil blowing are the main hazards. The systems of conservation tillage used to control erosion are similar to those in areas used for dryland farming. The irrigation system needs to be designed so that the water application rate does not exceed the moderate water intake rate of the Satanta soil.

These soils are suited to introduced grasses used as pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. This soil is subject to water erosion. Continuous heavy grazing or improper haying causes poor plant vigor and reduced forage production. Continuous heavy grazing and improper haying also reduces the amount of protective cover and can result in soil blowing and the formation of small gullies and rills after heavy rains. Managing separate pastures of cool- and warm-season grasses can extend the grazing season by supplying spring and fall grazing. Rotation grazing, proper stocking rates, and timely mowing help to maintain high productivity. Soil tests can indicate a

need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be added by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

If these soils are used for range or native hay, the climax vegetation on the Satanta soil is dominantly big bluestem, blue grama, little bluestem, sideoats grama, and western wheatgrass. These species make up 80 percent or more of the total annual forage. Buffalograss, needleandthread, prairie junegrass, Scribner panicum, switchgrass, sedges, and forbs make up the rest. The climax vegetation on the Canyon soil is dominantly little bluestem, sideoats grama, western wheatgrass, blue grama, and threadleaf sedge. These species make up 65 percent or more of the total annual forage. Prairie sandreed, needleandthread, green needlegrass, hairy grama, big bluestem, and forbs make up the rest. If subject to continuous heavy grazing, big bluestem, little bluestem, prairie junegrass, and switchgrass decrease in abundance on the Satanta soil, and little bluestem and big bluestem decrease in abundance on the Canyon soil. They are replaced by blue grama, buffalograss, needleandthread, plains muhly, sand dropseed, tall dropseed, western wheatgrass, and forbs on the Satanta soil and sideoats grama, blue grama, hairy grama, prairie sandreed, sand dropseed, threadleaf sedge, and forbs on the Canyon soil. If overgrazing continues for many years, the native grasses on the Satanta soil lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive. Woody plants may invade the site on the Canyon soil.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre on the Satanta soil and 0.5 animal unit month per acre on the Canyon soil. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded with a suitable grass mixture if they are used as range. In areas where gullies have formed because of severe water erosion, land shaping or other mechanical practices may be needed to smooth and stabilize the site before it is reseeded. Brush management may be needed in some areas to control the woody plants that invade the site.

The Satanta soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and soil erosion are the principal hazards affecting seedlings and young trees. Irrigation can

provide supplemental moisture during periods of low rainfall. Seedlings can survive and grow if competing vegetation between the tree rows is controlled by cultivation with conventional equipment. The undesirable grasses and weeds in the rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide. Planting an annual cover crop between the tree rows helps to control soil blowing. The Canyon soil is generally not suited to the trees and shrubs planted in windbreaks because of the shallow depth to bedrock.

In areas of the Satanta soil, the moderate permeability is a limitation on sites for septic tank absorption fields. Increasing the size of the absorption field can generally overcome this limitation. Land shaping and installing the distribution lines on the contour help to ensure that the absorption field functions properly. Septic tank absorption fields are generally not suited to areas of the Canyon soil because of the shallow depth to bedrock. A suitable alternative site should be selected. In areas of the Satanta soil, strengthening the foundations of buildings and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling. The soft bedrock of the Canyon soil generally can be easily excavated during the construction of dwellings with basements or buildings that have deep foundations. Dwellings and buildings on these soils should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. The sides of shallow excavations in the Satanta soil can cave in unless they are shored. Roads built on the Satanta soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Mixing coarser grained base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling and ensure better performance. The soft bedrock of the Canyon soil can be excavated during the construction of roads. Cutting and filling can provide a suitable grade for roads. Onsite investigation is needed before any engineering practices are applied.

The land capability units are IVe-3, dryland, and IVe-5, irrigated, for the Satanta soil and VIIs-4, dryland, for the Canyon soil. The Satanta soil is in the Silty range site and windbreak suitability group 5. The Canyon soil is in the Shallow Limy range site and windbreak suitability group 10.

**SsE—Satanta-Canyon complex, 11 to 20 percent slopes.** These moderately steep, well drained soils are on uplands. The very deep Satanta soil formed in loamy eolian material, and the shallow Canyon soil

formed in loamy material weathered from calcareous sandstone. The Satanta soil is on the mid and lower side slopes. The Canyon soil is on ridgetops and knolls. Areas range from 10 to 200 acres in size. They consist of about 45 to 60 percent Satanta soil and about 25 to 40 percent Canyon soil. These soils are so intermingled or mixed that separating them in mapping is not practical.

Typically, the surface layer of the Satanta soil is grayish brown, very friable fine sandy loam about 9 inches thick. The subsoil is about 23 inches thick. It is grayish brown, firm clay loam in the upper part and light brownish gray, friable, calcareous loam in the lower part. The underlying material is light gray to a depth of more than 60 inches. It is calcareous fine sandy loam in the upper part and loamy fine sand in the lower part. In some places the surface layer is loam or very fine sandy loam. In cultivated areas 20 to 40 percent of this soil is eroded. In these areas erosion has removed all or most of the original surface soil, and tillage has mixed the remaining surface soil with the subsoil. In most places the surface layer is light in color and calcareous. In some places the surface layer is clay loam. In some areas calcareous sandstone is at a depth of 40 to 60 inches.

Typically, the surface layer of the Canyon soil is dark grayish brown, very friable loam about 6 inches thick. The underlying material is light brownish gray, calcareous loam about 8 inches thick. Calcareous sandstone is at a depth of 14 inches. In cultivated areas erosion has removed all or most of the original surface soil, and the thickness of the loamy material over the sandstone bedrock has been reduced. In these areas numerous sandstone fragments have been dislodged by tillage equipment and are on the surface. In these areas the surface layer is typically light in color and calcareous. In some places the surface layer is very fine sandy loam or fine sandy loam.

Included with these soils in mapping are small areas of Busher and Tassel soils, which contain more sand than the Satanta and Canyon soils. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Satanta and Canyon soils. Available water capacity is moderate in the Satanta soil and very low in the Canyon soil. Organic matter content is moderately low in both soils. Runoff is rapid.

Nearly all of the acreage of these soils supports native grasses and is used for grazing. These soils are not suitable for cropland because of the moderately steep slope.

If these soils are used for range or native hay, the climax vegetation on the Satanta soil is dominantly big

bluestem, blue grama, little bluestem, sideoats grama, and western wheatgrass. These species make up 80 percent or more of the total annual forage. Buffalograss, needleandthread, prairie junegrass, Scribner panicum, switchgrass, sedges, and forbs make up the rest. The climax vegetation on the Canyon soil is dominantly little bluestem, sideoats grama, western wheatgrass, blue grama, hairy grama, big bluestem, and threadleaf sedge. These species make up 65 percent or more of the total annual forage. Prairie sandreed, needleandthread, green needlegrass, hairy grama, big bluestem, and forbs make up the rest. If subject to continuous heavy grazing, big bluestem, little bluestem, prairie junegrass, and switchgrass decrease in abundance on the Satanta soil, and little bluestem and big bluestem decrease in abundance on the Canyon soil. They are replaced by blue grama, buffalograss, needleandthread, plains muhly, sand dropseed, tall dropseed, threadleaf sedge, and forbs on the Canyon soil. If overgrazing continues for many years, the native grasses on the Satanta soil lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive. Woody plants may invade the site on the Canyon soil.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre on the Satanta soil and 0.5 animal unit month per acre on the Canyon soil. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range. In areas where gullies have formed because of severe water erosion, land shaping or other mechanical practices may be needed to smooth and stabilize the site before it is reseeded. Brush management may be needed in some areas to control the woody plants that invade the site.

The Satanta soil is suited to the trees and shrubs planted in windbreaks. The Canyon soil is generally not suited because of the shallow depth to bedrock. The lack of adequate seasonal rainfall and soil erosion are the main hazards on the Satanta soil. Supplemental water can provide needed moisture during dry periods. Seedlings can survive and grow if competing vegetation between the tree rows is controlled by cultivation with conventional equipment. The undesirable grasses and weeds in the rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide.

These soils generally are not suitable as sites for sanitary facilities because of the slope and the shallow depth to bedrock in the Canyon soil. A suitable alternative site should be selected. Dwellings should be designed so that they conform to the natural slope of the land, or the site should be graded to an acceptable gradient. In areas of the Canyon soil, the soft bedrock generally can be easily excavated during the construction of dwellings with basements or buildings that have deep foundations. In areas of the Satanta soil, strengthening the foundations of buildings and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling. The sides of shallow excavations in this soil can cave in unless they are shored. Cutting and filling generally can provide a suitable grade for roads. The soft bedrock can be excavated during the construction of roads in areas of the Canyon soil. Roads built on the Satanta soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance. In areas of the Satanta soil, mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The land capability unit is VIe-1, dryland, for the Satanta soil and VIIs-4, dryland, for the Canyon soil. The Satanta soil is in the Silty range site and windbreak suitability group 5. The Canyon soil is in the Shallow Limy range site and windbreak suitability group 10.

**TfG—Tassel-Rock outcrop complex, 9 to 70 percent slopes.** This map unit consists of the shallow, moderately steep to very steep, well drained Tassel soil and areas of Rock outcrop along upland drainageways. The Tassel soil formed in loamy material weathered from calcareous sandstone. The areas of Rock outcrop consist of calcareous sandstone that is exposed on the shoulders and ridgetops along the drainageways. Areas range from 20 to 300 acres in size. They consist of 40 to 60 percent Tassel soil and 20 to 30 percent areas of Rock outcrop. They are so intermingled or mixed that separating them in mapping is not practical.

Typically, the Tassel soil has a surface layer of grayish brown, very friable, calcareous very fine sandy loam about 6 inches thick. The transitional layer is light gray, very friable, calcareous very fine sandy loam about 3 inches thick. The underlying material is white, calcareous very fine sandy loam to a depth of 16 inches. Below this to a depth of more than 60 inches is white, calcareous sandstone. In some places the surface layer is loam or fine sandy loam. In some

areas the sandstone is below a depth of 20 inches. In other places the transitional layer and underlying material are fine sandy loam.

Typically, the areas of Rock outcrop consist of exposed white or light gray, calcareous sandstone. In most areas they do not support vegetation.

Included with this unit in mapping are small areas of Busher and Oglala soils. The included soils have a dark surface soil more than 7 inches thick and are more than 20 inches thick over sandstone. They are lower on the landscape than the Tassel soil and the areas of Rock outcrop. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Tassel soil, and available water capacity is very low. The organic matter content is moderately low. Runoff is rapid and very rapid.

All of the acreage in this map unit is used as range (fig. 14). It is not suited to farming because of the slope and the shallow depth to bedrock.

If this map unit is used as range, the climax vegetation on the Tassel soil is dominantly blue grama, sand bluestem, needleandthread, and little bluestem. These species make up 65 percent or more of the total annual forage. Prairie sandreed, switchgrass, and forbs make up the rest. If subject to continuous heavy grazing, little bluestem and switchgrass decrease in abundance and are replaced by sideoats grama, blue grama, hairy grama, prairie sandreed, sand dropseed, threadleaf sedge, and forbs. If overgrazing continues for many years, woody plants may invade the site.

If the range is in excellent condition, the suggested initial stocking rate on the Tassel soil is 0.5 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. The slope and the areas of Rock outcrop can hinder the movement of livestock. Brush management may be needed in some areas to control the woody plants that invade the site.

The Tassel soil generally is not suited to the trees and shrubs planted in windbreaks because of the slope and the shallow depth to bedrock. A few areas may be suitable for the trees or shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used.

The Tassel soil generally is not suitable for sanitary facilities because of the slope and the shallow depth to bedrock. A suitable alternative site should be selected. The soft sandstone can be excavated during the construction of dwellings with basements or buildings

that have deep foundations. Dwellings and buildings also need to be properly designed so that they conform to the natural slope of the land. Cutting and filling are generally needed to provide a suitable grade for roads.

The land capability unit is VIIIs-4, dryland, for the Tassel soil and VIIIs-8, dryland, for the areas of Rock outcrop. The Tassel soil is in the Shallow Limy range site. No range site is assigned to the areas of Rock outcrop. Both are in windbreak suitability group 10.

**TgG—Tassel-Ponderosa-Rock outcrop association, 9 to 70 percent slopes.** This map unit consists of the well drained, moderately steep to very steep Tassel and Ponderosa soils and areas of Rock outcrop. The shallow Tassel soil and the very deep Ponderosa soil formed in material weathered from calcareous sandstone. They are in the rough, tree-covered areas of the Pine Ridge. Deeply entrenched drainageways dissect the area. The Tassel soil and the areas of Rock outcrop are on ridgetops and the very steep upper side slopes. The Ponderosa soil is on the mid and lower side slopes. Areas range from 20 to several thousand acres in size. They consist of 20 to 40 percent Tassel soil, 25 to 35 percent Ponderosa soil, 10 to 20 percent areas of Rock outcrop, and 25 to 40 percent other soils, such as Vetal, Jayem, Oglala, Mitchell, Munjor, and Thirtynine soils. The two major soils and the areas of Rock outcrop are generally associated in a regular repeating pattern and are individually large enough to be mapped separately. The relative proportion of components can differ appreciably from one delineation to another.

Typically, the Tassel soil has a surface layer of pale brown, very friable, calcareous very fine sandy loam about 4 inches thick. The underlying material is very pale brown, calcareous very fine sandy loam to a depth of 14 inches. Very pale brown, calcareous sandstone is below a depth of about 14 inches. Many small sandstone fragments are scattered throughout the underlying material. In some places the surface layer, transitional layer, or underlying material is fine sandy loam or loamy very fine sand.

Typically, the Ponderosa soil has a surface layer of grayish brown, very friable very fine sandy loam about 9 inches thick. The transitional layer is pale brown, very friable very fine sandy loam about 14 inches thick. The underlying material is very pale brown, calcareous very fine sandy loam to a depth of 60 inches or more. Many small sandstone fragments are scattered throughout the underlying material. In some places the surface layer, transitional layer, or underlying material is loamy very fine sand.



**Figure 14.—A typical area of Tassel-Rock outcrop complex, 9 to 70 percent slopes, used as rangeland.**

The areas of Rock outcrop consist of calcareous sandstone.

Included with this unit in mapping are small areas of Oglala, Munjor, and Vetal soils. Oglala soils have sandstone at a depth of 20 to 40 inches and are on similar landscapes as the Tassel and Ponderosa soils. Munjor soils are stratified, are on creek bottoms, and are subject to flooding. Vetal soils are very deep, have a dark surface soil more than 20 inches thick, and are on footslopes. Included soils make up 5 to 25 percent of the unit.

Permeability is moderately rapid in the Tassel and Ponderosa soils. Available water capacity is very low in the Tassel soil and high in the Ponderosa soil. The organic matter content is moderately low in the Tassel and Ponderosa soils. Runoff is rapid.

This association is used as rangeland, woodland,

wildlife habitat, and recreational areas. It is not suited to cropland because of the slope.

About 50 to 75 percent of this association supports a mixture of grasses and trees, and the rest supports grazeable woodland or forest. If the Tassel and Ponderosa soils are used as range, the climax vegetation on the Tassel soil is dominantly blue grama, sand bluestem, needleandthread, and little bluestem. These species make up 45 percent or more of the total annual forage. Prairie sandreed, switchgrass, and forbs make up the rest. The climax vegetation on the Ponderosa soil is dominantly blue grama, sand bluestem, needleandthread, and little bluestem. These species make up 45 percent or more of the total annual forage. Prairie sandreed, switchgrass, green needlegrass, bluegrass, and forbs make up the rest. Ponderosa pine covers 5 to 15 percent of the area. If

subject to continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance on the Ponderosa soil, and little bluestem and switchgrass decrease in abundance on the Tassel soil. They are replaced by needleandthread, prairie sandreed, blue grama, Scribner panicum, sand dropseed, and forbs on the Ponderosa soil and sideoats grama, blue grama, hairy grama, prairie sandreed, sand dropseed, threadleaf sedge, and forbs on the Tassel soil. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive. Woody plants may invade the site on the Tassel soil.

If the range is in excellent condition, the suggested initial stocking rate is 0.5 animal unit month per acre. The range should be closely monitored during use and the stocking rates adjusted so that one soil does not become overgrazed. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. The slope and the areas of Rock outcrop can hinder the movement of livestock. Brush management may be needed in some areas to control the undesirable woody plants that invade the site.

These soils are generally not suited to the trees and shrubs planted in windbreaks because of the slope and the shallow depth to bedrock in areas of the Tassel soil. Some areas are suitable for the trees or shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used. Onsite investigation is needed to identify the areas that are suitable for planting trees. The grazeable woodland or forest in this association consists of dense stands of ponderosa pine, dominantly on the steep and very steep, north- and east-facing slopes in areas where the soils are deepest. Along the streams and drainageways, stands of such deciduous trees as green ash, American elm, and eastern cottonwood are common. Onsite investigation is needed to identify the areas that are suitable for timber production.

This association is suited to wildlife habitat and recreational uses. In addition to its scenic beauty, it provides excellent habitat for many species of animals and birds, including deer and wild turkey.

The Tassel and Ponderosa soils generally are not suitable for sanitary facilities because of the slope, the shallow depth to bedrock in areas of the Tassel soil, and the areas of Rock outcrop. Dwellings need to be

properly designed so that they conform to the natural slope of the land, or the soil can be graded to a suitable gradient. In areas of the Tassel soil, the soft bedrock can be excavated during the construction of dwellings with basements or buildings that have deep foundations. In areas of the Ponderosa soil, the sides of shallow excavations can cave in unless they are shored. Cutting and filling generally can provide a suitable grade for roads. In areas of the Ponderosa soil, a good surface drainage system can minimize the damage to roads caused by frost action. Onsite investigation is needed before any engineering practices are applied.

The land capability unit is VIIIs-4, dryland, for the Tassel soil; VIe-3, dryland, for the Ponderosa soil; and VIIIs-8, dryland, for the areas of Rock outcrop. The Tassel soil is in the Shallow Limy range site, and the Ponderosa soil is in the Savannah range site. No range site is assigned to the areas of Rock outcrop. The Tassel and Ponderosa soils and the areas of Rock outcrop are in windbreak suitability group 10.

#### **ThB—Thirtynine loam, 1 to 3 percent slopes.**

This very deep, very gently sloping, well drained soil is on uplands. It formed in loamy material weathered from siltstone. Areas range from 5 to 400 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 8 inches thick. The subsurface layer is dark grayish brown, friable loam about 7 inches thick. The subsoil is 15 inches thick. The upper part is brown, firm silty clay loam, and the lower part is very pale brown, friable, calcareous loam. The underlying material is very pale brown, calcareous loam to a depth of more than 60 inches. In some places the surface layer is silt loam or very fine sandy loam. In some areas siltstone is within a depth of 60 inches.

Included with this soil in mapping are small areas of Bridget and Mitchell soils. Bridget soils have less clay in the profile than the Thirtynine soil and are lower on the landscape. Mitchell soils do not have a dark surface layer and are on the steeper slopes. Included soils make up 10 to 15 percent of the unit.

Permeability is moderate in the Thirtynine soil, and available water capacity is high. The organic matter content is moderate. Runoff is slow. The water intake rate is moderately low.

Most of the acreage of this soil is used for dryland farming. A few areas are irrigated. The rest is used as rangeland.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Soil blowing and water erosion are slight hazards in areas where the soil surface is

not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, helps to conserve soil moisture and control soil blowing and water erosion. Returning crop residue to the soil helps to maintain the organic matter content and fertility and improves the water intake rate.

If irrigated, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. It is suited to sprinkler and gravity irrigation systems. Some land leveling is generally needed for gravity systems to ensure the uniform distribution of water. Soil blowing and water erosion are slight hazards. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control erosion and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone. Incorporating crop residue and green manure crops into the soil helps improve the organic matter content and fertility.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with other crops. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or trefoil, or warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Continuous heavy grazing causes poor plant vigor. Managing separate pastures of cool- and warm-season grasses can extend the grazing season. Rotation grazing and proper stocking help to maintain or improve the condition of the grasses. Soil tests can indicate a need for fertilization to improve the growth and vigor of the grasses. Irrigation water can be applied by sprinkler or gravity systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil erosion. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and erosion are the main hazards affecting young trees. Irrigation can provide supplemental moisture during periods of low rainfall. Planting an annual cover

crop between the tree rows helps to control soil blowing. Seedlings can survive and grow if competing vegetation between the rows is controlled by cultivation with conventional equipment. The undesirable grasses and weeds in the tree rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide.

The moderate permeability of this soil is a limitation affecting septic tank absorption fields, but increasing the size of the absorption field generally can overcome this limitation. Strengthening the foundations of buildings and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling. Roads built on this soil should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

The land capability units are IIe-1, dryland, and IIe-4, irrigated; Silty range site; and windbreak suitability group 3.

#### **ThC—Thirtynine loam, 3 to 6 percent slopes.**

This very deep, gently sloping, well drained soil is on uplands. It formed in loamy material weathered from siltstone. Areas range from 5 to 200 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 8 inches thick. The subsoil is about 19 inches thick. The upper part is grayish brown, firm silty clay loam, and the middle part is light gray, firm, calcareous silty clay loam. The lower part is white, friable, calcareous silt loam. The underlying material is white, calcareous very fine sandy loam to a depth of more than 60 inches. In some places the surface layer is silt loam or very fine sandy loam. In other places siltstone is within a depth of 60 inches. In cultivated areas 5 to 20 percent of this soil is eroded. In these areas erosion has removed all or most of the original surface soil, and tillage has mixed the remaining surface soil with the subsoil. In most places the surface layer is light in color and calcareous. In some places the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Bridget, Epping, and Mitchell soils. Mitchell soils do not have a dark surface layer and are on the steeper landscapes. Bridget soils have less clay in the profile than the Thirtynine soil and are lower on the landscape. Epping soils have siltstone within a depth of 20 inches and are on knolls and ridgetops. Included soils make up 10 to 15 percent of the unit.

Permeability is moderate in the Thirtynine soil, and available water capacity is high. The organic matter content is moderate. Runoff is medium. The water intake rate is moderately low.

Most of the acreage of this soil is used for dryland farming. A few areas are irrigated. The rest is used mainly as rangeland.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Water erosion and soil blowing are the principal hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, that keeps crop residue on the surface helps to control water erosion and soil blowing and conserve soil moisture. The use of cover crops during the winter helps to control soil blowing. Terraces and contour farming are also effective in controlling erosion and conserving moisture. Returning crop residue to the soil helps to maintain the organic matter content and fertility and improves the water intake rate.

If irrigated by a sprinkler system, this soil is suited to corn, field beans, small grains, alfalfa, and introduced grasses. Extensive land leveling is generally needed for gravity irrigation systems. Soil erosion is the principal hazard. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil erosion and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue and green manure crops into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone and result in water erosion on these slopes.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with other crops. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or trefoil, or warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. This soil is subject to water erosion. Continuous heavy grazing causes poor plant vigor and can result in the formation of small gullies and rills after heavy rains. Managing separate pastures of cool- and warm-season grasses can extend the grazing season. Rotation grazing and proper stocking help to maintain or improve the condition of the grasses. Nitrogen or phosphate fertilizer, or both, improves the growth and vigor of the grasses. Irrigation water can be applied by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil erosion. Continuous heavy

grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. As a result, water erosion and soil blowing are excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants. Range seeding may be needed to stabilize severely eroded areas of cropland.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and erosion are the main hazards affecting young trees. Irrigation can provide supplemental moisture during periods of low rainfall. Planting the trees on the contour and terracing help to control water erosion. Planting an annual cover crop between the tree rows helps to control soil blowing. Seedlings can survive and grow if competing vegetation between the rows is controlled by cultivation with conventional equipment. The undesirable grasses and weeds in the tree rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide.

The moderate permeability of this soil is a limitation affecting septic tank absorption fields, but increasing the size of the absorption field generally can overcome this limitation. Strengthening the foundations of buildings and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. Roads need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to ensure better performance.

The land capability units are IIIe-1, dryland, and IIIe-4, irrigated; Silty range site; and windbreak suitability group 3.

#### **ThD—Thirtynine loam, 6 to 9 percent slopes.**

This very deep, strongly sloping, well drained soil is on uplands. It formed in loamy material weathered from siltstone. Areas range from 5 to more than 500 acres in size.

Typically, the surface layer is grayish brown, friable loam about 8 inches thick. The subsoil is 17 inches thick. The upper part is brown and light brownish gray, firm silty clay loam. The lower part is light gray, friable, calcareous silt loam about 4 inches thick. The underlying material is very pale brown, calcareous very fine sandy loam to a depth of more than 60 inches. In some places the surface layer is silt loam or very fine sandy loam. In other places siltstone is within a depth of 60 inches. In cultivated areas 15 to 30 percent of this soil is eroded. In these areas erosion

has removed all or most of the original surface soil, and tillage has mixed the remaining surface soil with the subsoil. In most places the surface layer is light in color and calcareous. In some places the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Bridget, Epping, and Mitchell soils. Bridget soils have less clay in the profile than the Thirtynine soil and are lower on the landscape. Epping soils have siltstone at a depth of 10 to 20 inches and are on ridges and shoulders of side slopes. Mitchell soils do not have a dark surface layer. Included soils make up 10 to 15 percent of the unit.

Permeability is moderate in the Thirtynine soil, and available water capacity is high. The organic matter content is moderate. Runoff is medium. The water intake rate is moderately low.

Most of the acreage of this soil supports native grasses and is used as range. Some areas are used for cultivated crops.

If dryland farmed, this soil is poorly suited to small grains, alfalfa, and introduced grasses. Inadequate rainfall in summer generally limits the crops that can be grown. Water erosion and soil blowing are hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and stripcropping, that keeps crop residue on the surface helps to control soil blowing and water erosion and conserve soil moisture. Incorporating crop residue into the soil helps improve the organic matter content and fertility.

If irrigated by a sprinkler system, this soil is poorly suited to corn, small grains, alfalfa, and introduced grasses. It is not suited to gravity irrigation because of the slope. Water erosion and soil blowing are severe hazards in areas where the surface is not protected by crops or crop residue. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control water erosion and soil blowing and conserve soil moisture. The use of cover crops during the winter helps to control soil blowing. Returning crop residue and green manure crops to the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone and result in water erosion on these slopes.

This soil is poorly suited to introduced grasses used as pasture and hayland. These grasses can be rotated with other crops. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or trefoil, or warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. This

soil is subject to water erosion. Continuous heavy grazing causes poor plant vigor and can result in the formation of small gullies and rills after heavy rains. Managing separate pastures of cool- and warm-season grasses can extend the grazing season. Rotation grazing and proper stocking help to maintain or improve the condition of the grasses. Nitrogen or phosphate fertilizer, or both, improves the growth and vigor of the grasses. Irrigation water can be applied by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

If this soil is used for range or native hay, the climax vegetation is dominantly blue grama, little bluestem, sideoats grama, and western wheatgrass. These species make up 50 percent or more of the total annual forage. Buffalograss, needleandthread, prairie junegrass, Scribner panicum, big bluestem, switchgrass, sedges, and forbs make up the rest. If subject to continuous heavy grazing, big bluestem, little bluestem, prairie junegrass, and switchgrass decrease in abundance and are replaced by blue grama, buffalograss, needleandthread, plains muhly, sand dropseed, tall dropseed, western wheatgrass, and forbs. If overgrazing continues for many years, the native grasses lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range. In areas where gullies have formed because of severe water erosion, land shaping or other mechanical practices may be needed to smooth and stabilize the site before it is reseeded.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and soil erosion are the main hazards affecting young trees. Irrigation can provide supplemental moisture during periods of low rainfall. Planting the trees on the contour and terracing help to control water erosion. Planting an annual cover crop between the tree rows helps to control soil blowing. Seedlings can survive and grow if competing vegetation between the rows is controlled by cultivation with conventional equipment. The undesirable grasses and weeds in the tree rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide.

The moderate permeability of this soil is a limitation affecting septic tank absorption fields, but increasing the size of the absorption field generally can overcome this limitation. Strengthening the foundations of buildings and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. Roads built on this soil need to be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil. Coarser grained base material can be used to ensure better performance.

The land capability units are IVe-1, dryland, and IVe-4, irrigated; Silty range site; and windbreak suitability group 3.

**To—Tryon fine sandy loam, 0 to 1 percent slopes.** This very deep, nearly level, poorly drained soil is in sandhill valleys. It formed in eolian sand and sandy alluvium. This soil is subject to rare flooding. Areas range from 20 to 500 acres in size.

Typically, the surface layer is very dark grayish brown, very friable fine sandy loam about 6 inches thick. The underlying material extends to a depth of more than 60 inches. The upper part is light brownish gray fine sand; the middle part is light brownish gray, mottled loamy fine sand; and the lower part is light gray fine sand. In some places the profile is calcareous. In a few areas the soil is very poorly drained. In some areas the surface layer is loam or loamy fine sand.

Included with this soil in mapping are small areas of Els, calcareous; Gannett; lpage; and Marlake soils. Els, calcareous, and lpage soils are better drained than the Tryon soil and are higher on the landscape. Gannett soils have more silt and clay in the profile than the Tryon soil and are on similar landscapes. Marlake soils are lower on the landscape than the Tryon soil and have water above the surface for much of the growing season. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Tryon soil, and available water capacity is low. The organic matter content is high. Runoff is very slow. The soil has a seasonal high water table that ranges from the surface during wet years to a depth of about 1.5 feet during dry years. The water table normally recedes to a depth of 2 to 3 feet in late summer.

Most of the acreage of this soil supports native grasses used as hayland. A few areas are used for range.

This soil is not suited to farming because of the wetness caused by the high water table.

If this soil is used as range or hayland, the climax vegetation is dominantly big bluestem, indiangrass, prairie cordgrass, and switchgrass. These species make up 60 percent or more of the total annual forage. Bluegrass, slender wheatgrass, sedges, rushes, and forbs make up the rest. If subject to continuous heavy grazing or improperly harvested for hay, big bluestem, prairie cordgrass, switchgrass, and indiangrass decrease in abundance and are replaced by slender wheatgrass, western wheatgrass, plains muhly, and sedges. If overgrazing or improper haying continues for many years, bluegrass, western wheatgrass, sedges, rushes, and forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 1.8 animal unit months per acre. A planned grazing system that includes proper grazing use, timely deferments from grazing and haying, and restricted use during wet periods helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities result in a more uniform distribution of grazing. During wet periods, grazing and operating heavy machinery cause surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. Large meadows can be divided into three sections and the sections mowed in rotation. The order in which the sections are mowed should be changed in successive years. After the ground is frozen, livestock can graze without damaging the meadows. They should be removed in the spring before the ground thaws and the water table reaches a high level.

This soil is suited to the trees and shrubs planted in windbreaks. The main limitation affecting the establishment of windbreaks is the wetness caused by the high water table. The species selected for planting should be those that can withstand the occasional wetness. Tilling and planting seedlings should be delayed until after the soil has begun to dry. The weeds and undesirable grasses can be controlled by cultivating between the tree rows with conventional equipment and by the use of the appropriate kind of herbicide in the rows.

This soil is not suited to septic tank absorption fields or building sites because of the wetness caused by the high water table and the flooding. A suitable alternative site should be selected. The sides of shallow excavations can cave in unless they are shored. The excavations should be made during dry

periods. Constructing roads on suitable, well compacted fill material above the flood level, providing adequate side ditches, and installing culverts help protect roads from the damage caused by the flooding and the wetness.

The land capability unit is Vw-7, dryland; Wet Subirrigated range site; and windbreak suitability group 2D.

**Tp—Tryon fine sandy loam, wet, 0 to 1 percent slopes.** This very deep, nearly level, very poorly drained soil is in sandhill valleys. It formed in eolian sand and sandy alluvium. This soil is subject to rare flooding and is occasionally ponded in the spring and during wet periods. Areas range from 20 to 50 acres in size.

Typically, a layer of plant litter about 2 inches thick is on the surface. The surface layer is dark gray, friable fine sandy loam about 5 inches thick. The underlying material is light gray and white, mottled fine sand to a depth of more than 60 inches. In some places the profile is calcareous. In some areas the dark surface soil is more than 9 inches thick. In other places the surface layer is loam or loamy fine sand.

Included with this soil in mapping are small areas of Els, calcareous; Gannett; and Marlake soils. Els, calcareous, soils are somewhat poorly drained and are higher on the landscape than the Tryon soil. Gannett soils have more silt and clay in the profile than the Tryon soil and are on similar landscapes. Marlake soils are lower on the landscape than the Tryon soil and have water above the surface for much of the growing season. Included soils make up 5 to 10 percent of the unit.

Permeability is rapid in the Tryon soil, and available water capacity is low. The organic matter content is high. Runoff is very slow or ponded. The seasonal high water table ranges from about 0.5 foot above the surface during wet years to a depth of about 1.0 foot during dry years. The water table normally recedes to a depth of 1 to 2 feet in late summer.

Nearly all of the acreage of this soil supports native grasses used for grazing or as hayland.

This soil is not suited to farming because of the wetness caused by the high water table.

If this soil is used as range or hayland, the climax vegetation is dominantly prairie cordgrass, bluejoint reedgrass, northern reedgrass, and rushes. These species make up 65 percent or more of the total annual forage. Bluegrass, slender wheatgrass, green muhly, sedges, and forbs make up the rest. If subject to continuous heavy grazing or improperly harvested for hay, prairie cordgrass, bluejoint reedgrass, and northern reedgrass decrease in abundance and are

replaced by slender wheatgrass, bluegrass, green muhly, sedges, rushes, and forbs. If overgrazing or improper haying continues for many years, bluegrass, foxtail barley, sedges, rushes, and forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 2.0 animal unit months per acre. This soil produces a high quantity of low-quality forage. A planned grazing system that includes proper grazing use, timely deferments from grazing and haying, and restricted use during wet periods helps to maintain or improve the range condition. During wet periods, grazing and operating heavy machinery can cause surface compaction and the formation of mounds and ruts, which make grazing or harvesting hay difficult.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous. In wet years, some areas of hay cannot be harvested. After the ground is frozen, livestock can graze without damaging the meadows. They should be removed in the spring before the ground thaws.

This soil is not suited to the trees and shrubs planted in windbreaks because of the wetness caused by the high water table. A few marginal areas may be suitable for the trees or shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used.

This soil is not suited to septic tank absorption fields or building sites because of the wetness caused by the high water table and the flooding. A suitable alternative site should be selected. The sides of shallow excavations can cave in unless they are shored. The excavations should be made during dry periods. Constructing roads on suitable, well compacted fill material above the level of ponding or flooding, providing adequate side ditches, and installing culverts help protect roads from the damage caused by ponding and the wetness.

The land capability unit is Vw-7, dryland; Wetland range site; and windbreak suitability group 10.

**TtB—Tuthill loamy fine sand, 0 to 3 percent slopes.** This very deep, nearly level and very gently sloping, well drained soil is on uplands. It formed in loamy and sandy material. Areas range from 5 to 200 acres in size.

Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 7 inches thick. The subsurface layer is dark grayish brown, very friable loamy fine sand about 4 inches thick. The subsoil is about 19 inches thick. It is grayish brown and brown, firm sandy clay loam in the upper part and brown, very

friable fine sandy loam in the lower part. The underlying material is pale brown fine sand to a depth of 60 inches or more. In some areas the dark surface soil is less than 7 inches thick. In a few places the surface layer is fine sandy loam. In some areas the sandy underlying material is below a depth of 40 inches. In some places the underlying material is calcareous.

Included with this soil in mapping are small areas of Dailey, Jayem, Valent, and Vetal soils. The included soils have more sand in the profile than the Tuthill soil. Dailey and Valent soils are higher on the landscape. Jayem soils are on similar landscapes as the Tuthill soil. Vetal soils have a dark surface soil more than 20 inches thick and are lower on the landscape than the Tuthill soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the subsoil in the Tuthill soil and rapid in the underlying material. Available water capacity is moderate. The organic matter content is moderately low. Runoff is slow. The water intake rate is high.

Most of the acreage of this soil is used for range. The rest is used as cropland.

If dryland farmed, this soil is poorly suited to small grains, alfalfa, and introduced grasses. Inadequate rainfall in summer generally limits the cultivated crops that can be grown. Soil blowing is the principal hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. Stripcropping and the use of cover crops during the winter help to control soil blowing.

If irrigated by a sprinkler system, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. This soil is not suited to gravity irrigation systems because of the high water intake rate. Soil blowing is the principal hazard. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone.

If this soil is used for range or native hay, the climax vegetation is dominantly prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 60 percent or more of the total annual forage. Blue grama, switchgrass, and forbs

make up the rest. If subject to continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, prairie sandreed, blue grama, Scribner panicum, sand dropseed, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain healthy and vigorous.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and soil blowing are the main hazards affecting young trees. Irrigation can provide supplemental moisture during periods of low rainfall. Soil blowing can be controlled by maintaining strips of sod or a cover crop between the tree rows. Cultivation between the rows with conventional equipment can control the undesirable grasses and weeds in areas where strips of sod and cover crops are not used. The weeds and undesirable grasses in the tree rows can be controlled by the careful use of the appropriate kind of herbicide or hoeing by hand.

This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in pollution of the ground water. Strengthening the foundations for dwellings and buildings without basements and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling. The walls or sides of shallow excavations can be shored to prevent sloughing or caving. Mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The land capability units are IVe-6, dryland, and IIIe-10, irrigated; Sandy range site; and windbreak suitability group 5.

**TtD—Tuthill loamy fine sand, 3 to 9 percent slopes.** This very deep, gently sloping and strongly sloping, well drained soil is on uplands. It formed in

loamy and sandy material. Areas range from 5 to 50 acres in size.

Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 7 inches thick. The subsurface layer is also dark grayish brown, very friable loamy fine sand about 3 inches thick. The subsoil is 18 inches thick. The upper part is grayish brown and light brownish gray, firm sandy clay loam. The lower part is pale brown, friable fine sandy loam. The underlying material is fine sand to a depth of 60 inches or more. The upper part is light gray, and the lower part is white and calcareous. In some places the surface soil is fine sandy loam. In some areas the dark surface soil is less than 7 inches thick. In cultivated areas 20 to 35 percent of this soil is eroded. In these areas erosion has removed all or most of the original surface soil, and tillage has mixed the remaining surface soil with the subsoil. In most places the surface layer is light in color. In other places the surface layer is sandy clay loam or clay loam. In some areas the sandy underlying material is below a depth of 40 inches.

Included with this soil in mapping are small areas of Dailey, Jayem, Valent, and Vetal soils. Dailey, Valent, and Vetal soils have more sand in the profile than the Tuthill soil. Dailey and Valent soils are higher on the landscape. Vetal soils have a dark surface soil more than 20 inches thick and are lower on the landscape than the Tuthill soil. Jayem soils have less clay in the subsoil than the Tuthill soil and are on similar landscapes. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the subsoil in the Tuthill soil and rapid in the underlying material. Available water capacity is moderate. The organic matter content is moderately low. Runoff is medium. The water intake rate is high.

Most of the acreage of this soil is used for range. The rest is used as irrigated cropland.

This soil is not suited to dry-farmed crops because of droughtiness and the hazard of soil blowing.

If irrigated by a sprinkler system, this soil is poorly suited to corn, small grains, alfalfa, and introduced grasses. It is not suited to gravity irrigation systems because of the slope and the high water intake rate. Water erosion and soil blowing are severe hazards in areas where the surface is not protected by crops or crop residue. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control water erosion and soil blowing and conserve soil moisture. The use of winter cover crops helps to control soil blowing. Returning crop residue and green manure crops to the soil helps improve the organic matter content and fertility. The

efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone and result in water erosion on these slopes.

If this soil is used for range or native hay, the climax vegetation is dominantly prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 60 percent or more of the total annual forage. Blue grama, switchgrass, and other forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, prairie sandreed, blue grama, Scribner panicum, sand dropseed, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and erosion are the main hazards affecting young trees. Irrigation can provide supplemental moisture during periods of low rainfall. Soil blowing can be controlled by maintaining strips of sod or cover crops between the tree rows. Planting the trees on the contour and terracing help to control water erosion. Seedlings can survive and grow if competing vegetation between the tree rows is controlled by cultivation with conventional equipment. The undesirable grasses and weeds in the rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide.

This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Strengthening the foundations for dwellings and buildings without basements and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Mixing the base material

with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The land capability units are V1e-6, dryland, and IVe-10, irrigated; Sandy range site; and windbreak suitability group 5.

**TwB—Tuthill fine sandy loam, 0 to 3 percent slopes.** This very deep, nearly level and very gently sloping, well drained soil is on uplands. It formed in loamy and sandy material. Areas range from 5 to 600 acres in size.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 11 inches thick. The subsoil is firm sandy clay loam about 17 inches thick. The upper part is grayish brown, and the lower part is light grayish brown. The underlying material is white fine sand to a depth of more than 60 inches. In some places the sandy material is below a depth of 40 inches. In some areas the dark surface layer is less than 7 inches thick and is loamy fine sand. In other places the underlying material is calcareous.

Included with this soil in mapping are small areas of Jayem, Keya, and Vetal soils. Jayem soils have less clay in the subsoil than the Tuthill soil and are on similar landscapes. Keya and Vetal soils have a dark surface soil more than 20 inches thick and are lower on the landscape than the Tuthill soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the subsoil in the Tuthill soil and rapid in the underlying material. Available water capacity is moderate. The organic matter content is moderately low. Runoff is slow. The water intake rate is moderate.

Most of the acreage of this soil is used for farming. A few areas are used for range.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Soil blowing is the main hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, that keeps crop residue on the surface helps to control erosion and conserve soil moisture. The use of cover crops during the winter helps to control soil blowing. Returning crop residue to the soil helps to maintain the organic matter content and fertility and improves the water intake rate.

If irrigated, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. It is best suited to sprinkler and gravity irrigation systems. Some land leveling is generally needed for gravity systems to ensure the uniform distribution of water. Soil blowing is the principal

hazard. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control erosion and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue and green manure crops into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with other crops. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or trefoil, or warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Continuous heavy grazing reduces the amount of protective cover and the quality of the stands and can result in a severe hazard of soil blowing. Managing separate pastures of cool- and warm-season grasses can extend the grazing season. Rotation grazing and proper stocking help to maintain or improve the condition of the grasses. Nitrogen or phosphate fertilizer, or both, improves the growth and vigor of the grasses. Irrigation water can be applied by sprinkler or gravity systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants very effectively controls soil blowing. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. As a result, soil blowing is excessive. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and soil blowing are the main hazards affecting young trees. Irrigation can provide supplemental moisture during periods of low rainfall. Soil blowing can be controlled by maintaining strips of sod or a cover crop between the tree rows. Seedlings can survive and grow if competing vegetation between the rows is controlled by cultivation with conventional equipment. The undesirable grasses and weeds in the tree rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide.

This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Strengthening the foundations for dwellings and buildings without basements and backfilling with coarse textured material help to

prevent the damage caused by shrinking and swelling. The walls and sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Mixing the base material for roads and streets with additives, such as hydrated lime, helps to prevent shrinking and swelling.

The land capability units are IIIe-3, dryland, and IIe-5, irrigated; Sandy range site; and windbreak suitability group 5.

**TwC—Tuthill fine sandy loam, 3 to 6 percent slopes.** This very deep, gently sloping, well drained soil is on uplands. It formed in loamy and sandy material. Areas range from 5 to 700 acres in size.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 9 inches thick. The subsoil is firm sandy clay loam about 12 inches thick. The upper part is dark brown, and the lower part is brown. The underlying material extends to a depth of more than 60 inches. It is pale brown loamy fine sand in the upper part and very pale brown fine sand in the lower part. In some places the surface layer is loam or loamy fine sand. In some areas the dark surface soil is less than 7 inches thick. In cultivated areas 15 to 30 percent of this soil is eroded. In these areas erosion has removed all or most of the original surface soil, and tillage has mixed the remaining surface soil with the subsoil. In most places the surface layer is light in color. In other places the surface layer is sandy clay loam or clay loam. In other areas the sandy underlying material is below a depth of 40 inches.

Included with this soil in mapping are small areas of Dailey, Jayem, Keya, Satanta, and Vetal soils. Dailey soils have more sand in the upper part of the profile than the Tuthill soil and are higher on the landscape. Jayem soils have less clay in the subsoil than the Tuthill soil and are on similar landscapes. Satanta soils do not have sandy material within a depth of 40 inches and are on similar landscapes as the Tuthill soil. Vetal and Keya soils have a dark surface soil more than 20 inches thick and are lower on the landscape than the Tuthill soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the subsoil in the Tuthill soil and rapid in the underlying material. Available water capacity is moderate. The organic matter content is moderately low. Runoff is medium. The water intake rate is moderate.

Most of the acreage of this soil is used for range. Some areas are used for farming.

If dryland farmed, this soil is suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be successfully grown. Water erosion and soil blowing

are the principal hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, that keeps crop residue on the surface helps to control soil blowing and water erosion and conserve soil moisture. Cover crops also help to control erosion. Terraces and contour farming are also effective in controlling erosion and conserving moisture. Returning crop residue to the soil helps to maintain the organic matter content and fertility and improves the water intake rate.

If irrigated by a sprinkler system, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. Extensive land leveling is generally needed for gravity irrigation systems to be used on this soil. Soil blowing and water erosion are the principal hazards. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control erosion and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue and green manure crops into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients and pesticides below the root zone and result in water erosion on these slopes.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with other crops. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or trefoil, or warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. This soil is subject to water erosion. Continuous heavy grazing causes poor plant vigor and can result in the formation of small gullies and rills after heavy rains. Continuous heavy grazing also reduces the amount of protective cover and the quality of the stands, resulting in a severe hazard of soil blowing. Managing separate pastures of cool- and warm-season grasses can extend the grazing season. Rotation grazing and proper stocking help to maintain or improve the condition of the grasses. Nitrogen or phosphate fertilizer, or both, improves the growth and vigor of the grasses. Irrigation water can be applied by sprinkler systems. Weeds can be controlled if the appropriate kind of herbicide is applied.

If this soil is used for range or native hay, the climax vegetation is dominantly prairie sandreed, big bluestem, needleandthread, and little bluestem. These species make up 75 percent or more of the total annual forage. Blue grama, sand bluestem, switchgrass, and forbs make up the rest. If subject to

continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, prairie sandreed, blue grama, Scribner panicum, sand dropseed, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and erosion are the main hazards affecting young trees. Irrigation can provide supplemental moisture during periods of low rainfall. Soil blowing can be controlled by maintaining strips of sod or a cover crop between the tree rows. Cultivation between the rows with conventional equipment can control the undesirable grasses and weeds in areas where strips of sod and cover crops are not used. The weeds and undesirable grasses in the tree rows can be controlled by the careful use of the appropriate kind of herbicide or hoeing by hand.

This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Strengthening the foundations for dwellings and buildings without basements and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. The walls and sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Mixing the base material for roads and streets with additives, such as hydrated lime, helps to prevent shrinking and swelling.

The land capability units are IIIe-3, dryland, and IIIe-5, irrigated; Sandy range site; and windbreak suitability group 5.

**TwD—Tuthill fine sandy loam, 6 to 11 percent slopes.** This very deep, strongly sloping, well drained soil is on uplands. It formed in loamy and sandy material. Areas range from 5 to 200 acres in size.

Typically, the surface layer is grayish brown, very

friable fine sandy loam about 8 inches thick. The subsoil is 14 inches thick. The upper part is grayish brown, firm sandy clay loam. The lower part is light brownish gray, friable sandy clay loam. The underlying material to a depth of more than 60 inches is white. The upper part is loamy fine sand, and the lower part is calcareous fine sand. In some areas the dark surface layer is less than 7 inches thick and is loam or loamy fine sand. In cultivated areas 20 to 35 percent of this soil is eroded. In these areas erosion has removed all or most of the original surface soil, and tillage has mixed the remaining surface soil with the subsoil. In most places the surface layer is light in color. In other places the surface layer is sandy clay loam or loam. In a few areas the sandy underlying material is below a depth of 40 inches. In some places the underlying material is calcareous.

Included with this soil in mapping are small areas of Dailey, Jayem, and Valent soils. Dailey and Valent soils have more sand than the Tuthill soil and are higher on the landscape. Jayem soils have less clay in the subsoil than the Tuthill soil and are on similar landscapes. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the subsoil in the Tuthill soil and rapid in the underlying material. Available water capacity is moderate. The organic matter content is moderately low. Runoff is medium. The water intake rate is moderate.

Most of the acreage of this soil is used for range. A few areas are used as irrigated cropland or are dryland farmed.

If dryland farmed, this soil is poorly suited to small grains, introduced grasses, and alfalfa. Inadequate rainfall in summer generally limits the cultivated crops that can be grown. Water erosion and soil blowing are the principal hazards in areas where the surface is not adequately protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, that keeps crop residue on the surface helps to control soil blowing and water erosion and conserve soil moisture. Stripcropping and annual cover crops help to control soil blowing. Terraces reduce the runoff rate and help to control water erosion.

If irrigated by a sprinkler system, this soil is poorly suited to corn, small grains, alfalfa, and introduced grasses. Soil blowing and water erosion are the principal hazards if the surface is unprotected. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control water erosion and soil blowing and conserve soil moisture. Returning crop residue and green manure crops to the soil helps improve the organic

matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients and pesticides below the root zone and result in water erosion on these slopes.

If this soil is used for range or native hay, the climax vegetation is dominantly prairie sandreed, big bluestem, needleandthread, and little bluestem. These species make up 75 percent or more of the total annual forage. Blue grama, sand bluestem, switchgrass, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, prairie sandreed, blue grama, Scribner panicum, sand dropseed, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and erosion are the main hazards affecting young trees. Irrigation can provide supplemental moisture during periods of low rainfall. Soil blowing can be controlled by maintaining strips of sod or a cover crop between the tree rows. Cultivation between the rows with conventional equipment can control the undesirable grasses and weeds in areas where strips of sod and cover crops are not used. The undesirable grasses and weeds in the tree rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide.

This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Strengthening the foundations for dwellings and buildings without basements and backfilling with coarse textured material help to prevent the damage caused by shrinking and swelling. Dwellings and buildings also should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. The walls and sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

Mixing the base material for roads and streets with additives, such as hydrated lime, helps to prevent shrinking and swelling.

The land capability units are IVe-3, dryland, and IVe-5, irrigated; Sandy range site; and windbreak suitability group 5.

#### **VaB—Valent fine sand, 0 to 3 percent slopes.**

This very deep, nearly level and very gently sloping, excessively drained soil is in sandhill valleys. It formed in eolian sand. Areas range from 5 to 300 acres in size.

Typically, the surface layer is grayish brown, very friable fine sand about 6 inches thick. The underlying material is pale brown and very pale brown fine sand to a depth of more than 60 inches. In some places the surface layer is loamy fine sand.

Included with this soil in mapping are small areas of Dailey and Ipage soils. Dailey soils have a dark surface soil more than 10 inches thick and are lower on the landscape than the Valent soil. Ipage soils are moderately well drained and are lower on the landscape than the Valent soil. In a few areas they are gently sloping. Included soils make up 10 to 15 percent of the unit.

Permeability is rapid in the Valent soil. Available water capacity and organic matter content are low. Runoff is slow. The water intake rate is very high.

Most of the acreage of this soil is used as rangeland. The rest is used as irrigated cropland. This soil is not suited to dryland farming because of droughtiness and the hazard of soil blowing.

If irrigated by a sprinkler system, this soil is poorly suited to corn, small grains, alfalfa, and introduced grasses. It is too sandy for gravity irrigation systems. Frequent, light applications of water are needed. Soil blowing is the principal hazard. A system of conservation tillage, such as stubble mulching and ecofallow, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. Incorporating crop residue into the soil improves the organic matter content and fertility. Supplemental applications of nitrogen, phosphorus, zinc, and sulfur are needed for maximum crop production. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone.

If this soil is used for range or native hay, the climax vegetation is dominantly prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 65 percent or more of the total annual forage. Blue grama, switchgrass, and forbs make up the rest. If the pasture is overgrazed, sand bluestem, little bluestem, and switchgrass decrease in

abundance and are replaced by needleandthread, prairie sandreed, blue grama, Scribner panicum, sand dropseed, and forbs. If overgrazing continues for many years, the native plants lose vigor and soil blowing is excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. This soil is generally the first to be overgrazed in a pasture that includes the Sands or Choppy Sands range sites. Properly locating fences and livestock watering and salting facilities results in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, the forage should be harvested once every two years. During the year the forage is not harvested, the hayland should be used only as fall or winter range.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and soil blowing are the main hazards affecting young trees. Irrigation can provide supplemental moisture during periods of low rainfall. Because the soil is loose, trees should be planted in shallow furrows with as little disturbance of the soil as possible. Strips of sod or other vegetation is needed between the tree rows to control soil blowing. Seedlings can be damaged by high winds and covered by drifting sand. The undesirable grasses and weeds in the tree rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide.

This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in pollution of the ground water. This soil is generally suited to dwellings, buildings, and roads. Seeding the roadside after construction helps to stabilize the loose soil. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

The land capability units are VIe-5, dryland, and IVe-12, irrigated; Sandy range site; and windbreak suitability group 7.

**VaD—Valent fine sand, 3 to 9 percent slopes.**

This very deep, gently sloping and strongly sloping, excessively drained soil is on dunes in the sandhills and in transitional areas bordering the sandhills. It formed in eolian sand. Areas range from 10 to 500 acres in size.

Typically, the surface layer is dark grayish brown, loose fine sand about 5 inches thick. The underlying

material is pale brown fine sand to a depth of more than 60 inches. In a few areas the surface layer is loamy fine sand.

Included with this soil in mapping are small areas of Dailey; Els, calcareous; Ipage; and Jayem soils. Dailey soils have a dark surface soil more than 10 inches thick and are lower on the landscape than the Valent soil. Els, calcareous, and Ipage soils are lower on the landscape than the Valent soil and are not as well drained. Jayem soils are well drained and have more silt in the profile than the Valent soil. These soils are on similar landscapes. In a few small areas the Valent soil is very gently sloping. Included soils make up 10 to 15 percent of the unit.

Permeability is rapid in the Valent soil, and available water capacity is low. The organic matter content is low. Runoff is slow. The water intake rate is very high.

Most of the acreage of this soil is used as rangeland. Some areas are used for irrigated crops.

This soil is not suited to dryland farming because it is too droughty and soil blowing is a severe hazard.

If irrigated by a sprinkler system, this soil is poorly suited to corn, small grains, alfalfa, and introduced grasses. It is too sandy for gravity irrigation systems. Frequent, light applications of water are needed. Soil blowing is the principal hazard. A system of conservation tillage, such as stubble mulching and ecofallow, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. Incorporating crop residue into the soil improves the organic matter content and fertility. Supplemental applications of nitrogen, phosphorus, zinc, and sulfur are needed for maximum crop production. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone.

If this soil is used as range or hayland, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, and needleandthread. These species make up 65 percent or more of the total annual forage. Blue grama, switchgrass, sand lovegrass, sedges, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, blue grama, sand dropseed, sedges, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, soil blowing is excessive and blowouts can form.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying

helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and soil blowing are the main hazards affecting young trees. Irrigation can provide supplemental moisture during periods of low rainfall. Because the soil is loose, trees should be planted in shallow furrows with as little disturbance of the soil as possible. Strips of sod or other vegetation is needed between the tree rows to control soil blowing. Seedlings can be damaged by high winds and covered by drifting sand. The undesirable grasses and weeds in the tree rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide.

This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in pollution of the ground water. This soil is generally suited to dwellings and roads. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. Seeding the roadside after construction helps to stabilize the loose soil. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

The land capability units are V1e-5, dryland, and IVe-12, irrigated; Sands range site; and windbreak suitability group 7.

**VaE—Valent fine sand, rolling.** This very deep, excessively drained soil is on dunes in areas of the sandhills. It formed in eolian sand. Slopes range from 9 to 24 percent. Areas range from 80 to 2,000 acres in size.

Typically, the surface layer is grayish brown, loose fine sand about 4 inches thick. The underlying material is pale brown fine sand to a depth of more than 60 inches.

Included with this soil in mapping are small areas of Dailey; Els, calcareous; and lpage soils. Dailey soils have a dark surface soil more than 10 inches thick. Els, calcareous, soils are somewhat poorly drained, and lpage soils are moderately well drained. These soils are lower on the landscape than the Valent soil. In a few places the soil is very steep. Included soils make up 5 to 10 percent of the unit.

Permeability is rapid in the Valent soil, and available water capacity is low. The organic matter content is low. Runoff is slow and medium.

Nearly all of the areas of this soil support native grasses used for grazing or as hayland.

This soil is not suited to farming because of the slope, droughtiness, and the severe hazard of soil blowing.

If this soil is used as range or hayland, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, and needleandthread. These species make up 65 percent or more of the total annual forage. Blue grama, switchgrass, sand lovegrass, sedges, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, blue grama, sand dropseed, sedges, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, soil blowing is excessive and blowouts can form.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and soil blowing are the main hazards affecting young trees. Irrigation can provide supplemental moisture during periods of low rainfall. Because the soil is loose, trees should be planted in shallow furrows with as little disturbance of the soil as possible. Strips of sod or other vegetation is needed between the tree rows to control soil blowing. Seedlings can be damaged by high winds and covered by drifting sand. The undesirable grasses and weeds in the tree rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide.

This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in pollution of the ground water. Land shaping and installing septic tank absorption fields on the contour are generally necessary for their proper operation. Dwellings and buildings need to be properly designed so that they conform to the natural slope of the land, or the soil can be graded to a suitable gradient. Cutting and filling are generally needed to provide a suitable grade for roads. Seeding the roadside after construction helps to

stabilize the loose soil. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

The land capability unit is Vle-5, dryland; Sands range site; and windbreak suitability group 7.

**VaF—Valent complex, rolling and hilly.** This very deep, excessively drained soil is on dunes in the sandhills. It formed in eolian sand. Individual areas range from 80 to several thousand acres in size. They consist of 55 to 80 percent Valent fine sand, rolling, and 20 to 45 percent Valent fine sand, hilly. Slopes range from 9 to 24 percent in the rolling part and 24 to 60 percent in the hilly part. Catsteps are common on the side slopes in the hilly part. These soils are so intermingled or mixed that separating them in mapping is not practical.

Typically, the surface layer of the Valent, rolling, soil is grayish brown, loose fine sand about 4 inches thick. The underlying material is pale brown fine sand to a depth of more than 60 inches.

Typically, the surface layer of the Valent, hilly, soil is grayish brown, loose fine sand about 3 inches thick. The underlying material is pale brown and very pale brown fine sand to a depth of more than 60 inches.

Included with this soil in mapping are small areas of Dailey; Els, calcareous; and lpage soils. The included soils are in sandhill valleys. Dailey soils have a dark surface soil more than 10 inches thick. Els, calcareous, soils are somewhat poorly drained, and lpage soils are moderately well drained. Included soils make up less than 10 percent of the unit.

Permeability is rapid in the Valent soil, and available water capacity is low. The organic matter content is low. Runoff is slow and medium in the rolling part and medium in the hilly part.

All of the areas of this soil support native grasses used as rangeland.

This soil is not suited to farming because of the slope, droughtiness, and the severe hazard of soil blowing.

If this soil is used for range, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, and needleandthread. These species make up 65 percent or more of the total annual forage. Blue grama, switchgrass, sand lovegrass, sedges, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, blue grama, sand dropseed, sedges, and forbs in the rolling part and needleandthread, prairie sandreed, hairy grama, sand dropseed, sandhill muhly, sedges, and forbs in the hilly part. If overgrazing continues for many years,

the native plants lose vigor and are unable to stabilize the site. As a result, soil blowing is excessive and blowouts can form.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre on the rolling part and 0.6 animal unit month per acre on the hilly part. The stocking rate is determined by the percentage of each soil in the pasture. The range should be closely monitored during use and the stocking rates adjusted so that one soil does not become overgrazed. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing.

Small soapweed increases in abundance in areas of the range used only as summer pasture. It can be controlled by using the pasture as winter range. Blowouts can be stabilized in a few years by a planned grazing system. Steep banks should be sloped to a stable grade before they are revegetated. If fences are used to exclude livestock, shaping, seeding, and mulching the blowouts can hasten the reclamation process.

The Valent, rolling, part is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and soil blowing are the main hazards affecting young trees. Irrigation can provide supplemental moisture during periods of low rainfall. Because the soil is loose, trees should be planted in shallow furrows with as little disturbance of the soil as possible. Strips of sod or other vegetation is needed between the tree rows to control soil blowing. Seedlings can be damaged by high winds and covered by drifting sand. The undesirable grasses and weeds in the tree rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide. The Valent, hilly, part is not suited to the trees and shrubs planted in windbreaks because of the slope. A few areas may be suitable for the trees or shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used.

This soil is not suitable for sanitary facilities on the steep and very steep slopes. On the moderately steep slopes, land shaping and installing septic tank absorption fields on the contour are generally necessary for their proper operation. The poor filtering capacity can result in pollution of the ground water. Dwellings and buildings need to be properly designed so that they conform to the natural slope of the land, or the soil can be graded to a suitable gradient. Cutting

and filling are generally needed to provide a suitable grade for roads. Seeding the roadside after construction helps to stabilize the loose soil. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

The land capability units are VIe-5, dryland, for the Valent, rolling, soil and VIIe-5, dryland, for the Valent, hilly, soil. The rolling part is in the Sands range site and windbreak suitability group 7. The hilly part is in the Choppy Sands range site and windbreak suitability group 10.

**VaG—Valent fine sand, hilly.** This very deep, excessively drained soil is on dunes in the sandhills. Slopes range from 24 to 60 percent. The soil formed in eolian sand. Catsteps are common. Individual areas range from 80 to 2,000 acres in size.

Typically, the surface layer is grayish brown, loose fine sand about 3 inches thick. The underlying material is pale brown fine sand to a depth of more than 60 inches.

Included with this soil in mapping are small, gently sloping areas. Included areas make up about 5 to 10 percent of the unit.

Permeability is rapid in the Valent soil, and available water capacity is low. The organic matter content is low. Runoff is medium.

All of this soil is used as rangeland.

This soil is not suited to farming because of the very steep slope.

If this soil is used as range, the climax vegetation is dominantly sand bluestem, little bluestem, switchgrass, prairie sandreed, and needleandthread. These species make up 80 percent or more of the total annual forage. Sand lovegrass, blue grama, sandhill muhly, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, prairie sandreed, hairy grama, sand dropseed, sandhill muhly, sedges, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, soil blowing is possible and blowouts can form.

If the range is in excellent condition, the suggested initial stocking rate is 0.6 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing.

This soil is not suited to the trees and shrubs planted in windbreaks because of the slope. A few

areas may be suitable for the trees or shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used.

This soil generally is not suitable for sanitary facilities or dwellings and buildings because of the steep and very steep slopes. A suitable alternative site should be selected. Cutting and filling are generally needed to provide a suitable grade for roads. Seeding the roadside after construction helps to stabilize the loose soil. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

The land capability unit is VIIe-5, dryland; Choppy Sands range site; and windbreak suitability group 10.

**VeB—Valent loamy fine sand, 0 to 3 percent slopes.** This very deep, nearly level and very gently sloping, excessively drained soil is in sandhill valleys and in transitional areas bordering the sandhills. It formed in eolian sand. Individual areas range from 10 to 340 acres in size.

Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 6 inches thick. The underlying material is light brownish gray, loose fine sand to a depth of more than 60 inches. In some places the surface layer is fine sand.

Included with this soil in mapping are small areas of Dailey, Jayem, and Tuthill soils. Dailey soils have a dark surface soil more than 10 inches thick and are lower on the landscape than the Valent soil. Jayem and Tuthill soils have more silt and clay in the profile than the Valent soil and are lower on the landscape. In a few areas the soil is gently sloping. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Valent soil, and available water capacity is low. The organic matter content is low. Runoff is slow. The water intake rate is very high.

Nearly all of the acreage of this soil is used as rangeland. The rest is used for irrigated crops.

This soil is not suited to dryland farming because of droughtiness and the hazard of soil blowing.

If irrigated by a sprinkler system, this soil is poorly suited to corn, small grains, alfalfa, and introduced grasses. It is too sandy for gravity irrigation systems. Frequent, light applications of water are needed. Soil blowing is the principal hazard. A system of conservation tillage, such as stubble mulching and ecofallow, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. Incorporating crop residue into the soil improves the organic matter content and fertility. Supplemental applications of nitrogen, phosphorus, zinc, and sulfur are needed for maximum crop

production. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone.

If this soil is used for range or native hay, the climax vegetation is dominantly prairie sandreed, sand bluestem, needleandthread, and little bluestem. These species make up 65 percent or more of the total annual forage. Blue grama, switchgrass, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, prairie sandreed, blue grama, Scribner panicum, sand dropseed, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, water erosion and soil blowing are excessive.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. This soil is generally the first to be overgrazed in a pasture that includes the Sands or Choppy Sands range sites. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain healthy and vigorous.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and soil blowing are the main hazards affecting young trees. Irrigation can provide supplemental moisture during periods of low rainfall. Because the soil is loose, trees should be planted in shallow furrows with as little disturbance of the soil as possible. Strips of sod or other vegetation is needed between the tree rows to control soil blowing. Seedlings can be damaged by high winds and covered by drifting sand. The undesirable grasses and weeds in the tree rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide.

This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in pollution of the ground water. This soil is generally suited to dwellings, buildings, and roads. Seeding the roadside after construction helps to stabilize the loose soil. The walls

or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

The land capability units are V1e-5, dryland, and I1e-11, irrigated; Sandy range site; and windbreak suitability group 7.

**VeD—Valent loamy fine sand, 3 to 9 percent slopes.** This very deep, gently sloping and strongly sloping, excessively drained soil is on dunes in transitional areas bordering the sandhills. It formed in eolian sand. Individual areas range from 10 to 100 acres in size.

Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 5 inches thick. The underlying material is pale brown fine sand to a depth of more than 60 inches. In some places the surface layer is fine sand.

Included with this soil in mapping are small areas of Dailey, Jayem, and Tuthill soils. Dailey soils have a dark surface soil more than 10 inches thick and are lower on the landscape than the Valent soil. Jayem and Tuthill soils have more silt and clay in the profile than the Valent soil and are lower on the landscape. In a few areas the soil is very gently sloping. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Valent soil, and available water capacity is low. The organic matter content is low. Runoff is slow. The water intake rate is very high.

Nearly all of the acreage of this unit is used as rangeland. A few areas are used for irrigated crops.

This soil is not suited to dryland farming because of droughtiness and the hazard of soil blowing.

If irrigated by a sprinkler system, this soil is poorly suited to corn, small grains, alfalfa, and introduced grasses. It is too sandy for gravity irrigation systems. Frequent, light applications of water are needed. Soil blowing is the principal hazard. A system of conservation tillage, such as stubble mulching and ecofallow, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. Incorporating crop residue into the soil improves the organic matter content and fertility. Supplemental applications of nitrogen, phosphorus, zinc, and sulfur are needed for maximum crop production. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone.

If this soil is used as range or hayland, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, and needleandthread. These species make up 65 percent or more of the total annual forage. Blue grama, switchgrass, sand lovegrass, sedges, forbs, and shrubs make up the rest. If subject to continuous heavy grazing, sand

bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, blue grama, sand dropseed, sedges, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, soil blowing is excessive and blowouts can form.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing or haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and soil blowing are the main hazards affecting young trees. Irrigation can provide supplemental moisture during periods of low rainfall. Because the soil is loose, trees should be planted in shallow furrows with as little disturbance of the soil as possible. Strips of sod or other vegetation is needed between the tree rows to control soil blowing. Seedlings can be damaged by high winds and covered by drifting sand. The undesirable grasses and weeds in the tree rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide.

This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in pollution of the ground water. This soil is generally suited to dwellings and roads. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. Seeding the roadside after construction helps to stabilize the loose soil. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

The land capability units are VIe-5, dryland, and IVe-11, irrigated; Sands range site; and windbreak suitability group 7.

#### **VnD—Valentine fine sand, 3 to 9 percent slopes.**

This very deep, gently sloping and strongly sloping, excessively drained soil is on dunes in the sandhills. It formed in eolian sand. Areas range from 10 to 500 acres in size.

Typically, the surface layer is light brownish gray, loose fine sand about 4 inches thick. The underlying material is very pale brown fine sand to a depth of more than 60 inches. In a few places the surface layer is loamy fine sand.

Included with this soil in mapping are small areas of lpage soils, which are lower on the landscape than the Valentine soil and are moderately well drained. Also included are small areas of very gently sloping soils. Included soils make up 10 to 15 percent of the unit.

Permeability is rapid in the Valentine soil, and available water capacity is low. The organic matter content is low. Runoff is slow. The water intake rate is very high.

Most of the acreage of this soil supports native grasses used for grazing. Some areas are used for irrigated crops.

This soil is not suited to dryland farming because of droughtiness and the hazard of soil blowing.

If irrigated by a sprinkler system, this soil is poorly suited to corn, small grains, alfalfa, and introduced grasses. It is too sandy for gravity irrigation systems. Frequent, light applications of water are needed. Soil blowing is the principal hazard. A system of conservation tillage, such as stubble mulching and ecofallow, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. Incorporating crop residue into the soil improves the organic matter content and fertility. Supplemental applications of nitrogen, phosphorus, zinc, and sulfur are needed for maximum crop production. The efficient use of irrigation water is a management concern because excessive amounts of water can leach plant nutrients below the root zone.

If this soil is used as range or hayland, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, and needleandthread. These species make up 70 percent or more of the total annual forage. Blue grama, switchgrass, sand lovegrass, sedges, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, blue grama, sand dropseed, sedges, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, soil blowing is excessive and blowouts can form.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

This soil is suited to the trees and shrubs planted in

windbreaks. The lack of adequate seasonal rainfall and soil blowing are the main hazards affecting young trees. Irrigation can provide supplemental moisture during periods of low rainfall. Because the soil is loose, trees should be planted in shallow furrows with as little disturbance of the soil as possible. Strips of sod or other vegetation is needed between the tree rows to control soil blowing. Seedlings can be damaged by high winds and covered by drifting sand. The undesirable grasses and weeds in the tree rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide.

This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in pollution of the ground water. This soil is generally suited to dwellings and roads. Buildings should be designed so that they conform to the natural slope of the land, or the site should be graded to a suitable gradient. Seeding the roadside after construction helps to stabilize the loose soil. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

The land capability units are V1e-5, dryland, and IVe-12, irrigated; Sands range site; and windbreak suitability group 7.

**VnE—Valentine fine sand, rolling.** This very deep, excessively drained soil is on dunes in the sandhills. It formed in eolian sand. Slopes range from 9 to 24 percent. Areas range from 80 to 2,000 acres in size.

Typically, the surface layer is pale brown, loose fine sand about 6 inches thick. The underlying material is very pale brown fine sand to a depth of more than 60 inches.

Included with this soil in mapping are small areas of lpage soils, which are lower on the landscape than the Valentine soil and are moderately well drained. Also included are small areas that have a slope of less than 9 percent or more than 24 percent. Included areas make up 5 to 10 percent of the unit.

Permeability is rapid in the Valentine soil, and available water capacity is low. The organic matter content is low. Runoff is slow and medium.

Nearly all of the areas of this soil support native grasses used for grazing. A few small areas on some of the gentler slopes are cut for hay.

This soil is not suited to farming because of the slope, droughtiness, and the severe hazard of soil blowing.

If this soil is used as range or hayland, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, and needleandthread. These species make up 70 percent or more of the total annual forage. Blue grama, switchgrass, sand

lovegrass, sedges, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, blue grama, sand dropseed, sedges, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, soil blowing is excessive and blowouts can form.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain vigorous and healthy.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and soil blowing are the main hazards affecting young trees. Irrigation can provide supplemental moisture during periods of low rainfall. Because the soil is loose, trees should be planted in shallow furrows with as little disturbance of the soil as possible. Strips of sod or other vegetation is needed between the tree rows to control soil blowing. Seedlings can be damaged by high winds and covered by drifting sand. The undesirable grasses and weeds in the tree rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide.

This soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in pollution of the ground water. Land shaping and installing septic tank absorption fields on the contour are generally necessary for their proper operation. Dwellings and buildings need to be properly designed so that they conform to the natural slope of the land, or the soil can be graded to a suitable gradient. Cutting and filling are generally needed to provide a suitable grade for roads. Seeding the roadside after construction helps to stabilize the loose soil. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

The land capability unit is V1e-5, dryland; Sands range site; and windbreak suitability group 7.

**VnF—Valentine complex, rolling and hilly.** This very deep, excessively drained soil is on dunes in the sandhills. It formed in eolian sand. Individual areas range from 80 to several thousand acres in size. They consist of 55 to 80 percent Valentine fine sand, rolling, and 20 to 45 percent Valentine fine sand, hilly. Slopes range from 9 to 24 percent in the rolling part and 24 to 60 percent in the hilly part. Catsteps are common on the side slopes in the hilly part. These soils are so intermingled or mixed that separating them in mapping is not practical.

Typically, the surface layer of the Valentine, rolling, soil is pale brown, loose fine sand about 5 inches thick. The underlying material is very pale brown fine sand to a depth of more than 60 inches.

Typically, the surface layer of the Valentine, hilly, soil is very pale brown, loose fine sand about 4 inches thick. The underlying material is very pale brown fine sand to a depth of more than 60 inches.

Included with this soil in mapping are small areas of lpage soils, which are lower on the landscape than the Valentine soil and are moderately well drained. Also included are small areas that have a slope of less than 9 percent. Included areas make up 5 to 10 percent of the unit.

Permeability is rapid in the Valentine soil, and available water capacity is low. The organic matter content is low. Runoff is slow and medium in the rolling part and medium in the hilly part.

All of the areas of this soil support native grasses used for grazing.

This soil is not suited to farming because of the slope, droughtiness, and the severe hazard of soil blowing.

If this soil is used as range or hayland, the climax vegetation is dominantly sand bluestem, little bluestem, prairie sandreed, and needleandthread. These species make up 70 percent or more of the total annual forage. Blue grama, switchgrass, sand lovegrass, sedges, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, blue grama, sand dropseed, sedges, and forbs in the rolling part and needleandthread, prairie sandreed, hairy grama, sand dropseed, sandhill muhly, sedges, and forbs in the hilly part. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, soil blowing is excessive and blowouts can form.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre in the rolling part and 0.6 animal unit month per acre in

the hilly part. The stocking rate is determined by the percentage of each soil in the pasture. The range should be closely monitored during use and the stocking rates adjusted so that one soil does not become overgrazed. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing.

Small soapweed increases in abundance in areas of the range used only as summer pasture. It can be controlled by using the pasture as winter range. Blowouts can be stabilized in a few years by a planned grazing system. Steep banks should be sloped to a stable grade before they are revegetated. If fences are used to exclude livestock, shaping, seeding, and mulching the blowouts can hasten the reclamation process.

The Valentine, rolling, soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and soil blowing are the main hazards affecting young trees. Irrigation can provide supplemental moisture during periods of low rainfall. Because the soil is loose, trees should be planted in shallow furrows with as little disturbance of the soil as possible. Strips of sod or other vegetation is needed between the tree rows to control soil blowing. Seedlings can be damaged by high winds and covered by drifting sand. The undesirable grasses and weeds in the tree rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide. The Valentine, hilly, soil is not suited to the trees and shrubs planted in windbreaks because of the steep slope. A few areas may be suitable for the trees or shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used.

This soil is not suitable for sanitary facilities on the steep and very steep slopes. On the moderately steep slopes, land shaping and installing septic tank absorption fields on the contour are generally necessary for their proper operation. The poor filtering capacity can result in pollution of the ground water. Dwellings and buildings need to be properly designed so that they conform to the natural slope of the land, or the soil can be graded to a suitable gradient. Cutting and filling are generally needed to provide a suitable grade for roads. Seeding the roadside after construction helps to stabilize the loose soil. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

The land capability units are Vle-5, dryland, for the

Valentine, rolling, soil and Vlle-5, dryland, for the Valentine, hilly, soil. The rolling part is in the Sands range site and windbreak suitability group 7. The hilly part is in the Choppy Sands range site and windbreak suitability group 10.

**VnG—Valentine fine sand, hilly.** This very deep, excessively drained soil is on dunes in the sandhills. Slopes range from 24 to 60 percent. It formed in eolian sand. Catsteps are common. Individual areas range from 80 to 2,000 acres in size.

Typically, the surface layer is grayish brown, loose fine sand about 3 inches thick. The underlying material is pale brown fine sand to a depth of more than 60 inches.

Included with this soil in mapping are small areas of Valentine soils that have slopes of less than 24 percent. Included soils make up about 5 to 10 percent of the unit.

Permeability is rapid in the Valentine soil, and available water capacity is low. The organic matter content is low. Runoff is medium.

All of the acreage of this soil supports native grasses used for grazing.

This soil is not suited to farming because of the very steep slope.

If this soil is used as range, the climax vegetation is dominantly sand bluestem, little bluestem, switchgrass, prairie sandreed, and needleandthread. These species make up 75 percent or more of the total annual forage. Sand lovegrass, blue grama, sandhill muhly, and forbs make up the rest. If subject to continuous heavy grazing, sand bluestem, sand lovegrass, little bluestem, and switchgrass decrease in abundance and are replaced by needleandthread, prairie sandreed, hairy grama, sand dropseed, sandhill muhly, sedges, and forbs. If overgrazing continues for many years, the native plants lose vigor and are unable to stabilize the site. As a result, soil blowing is possible and blowouts can form.

If the range is in excellent condition, the suggested initial stocking rate is 0.6 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing.

This soil is not suited to the trees and shrubs planted in windbreaks because of the slope. A few areas may be suitable for the trees or shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used.

This soil generally is not suitable for sanitary facilities because of the slope. A suitable alternative site should be selected. Dwellings and buildings need to be properly designed so that they conform to the natural slope of the land, or the soil can be graded to a suitable gradient. Cutting and filling are generally needed to provide a suitable grade for roads. Seeding the roadside after construction helps to stabilize the loose soil. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

The land capability unit is Vlle-5, dryland; Choppy Sands range site; and windbreak suitability group 10.

**VsB—Vetal loamy fine sand, 0 to 3 percent slopes.** This very deep, nearly level and very gently sloping, well drained soil is on foot slopes and in upland swales. It formed in loamy and sandy alluvium and eolian sediments. Areas range from 5 to 100 acres in size.

Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 7 inches thick. The subsurface layer is very dark grayish brown, very friable fine sandy loam about 18 inches thick. The transitional layer is dark grayish brown, very friable fine sandy loam about 15 inches thick. The underlying material to a depth of 60 inches or more is grayish brown loamy fine sand. In some places the surface layer is fine sandy loam or loamy very fine sand. In other places the dark surface soil is less than 20 inches thick. In some areas the profile has more very fine sand and less silt.

Included with this soil in mapping are small areas of Dailey and Tuthill soils. The included soils have a dark surface soil less than 20 inches thick. Dailey soils have more sand throughout the profile than the Vetal soil and are somewhat excessively drained. These soils are higher on the landscape. Tuthill soils have more clay in the profile than the Vetal soil and are higher on the landscape. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Vetal soil, and available water capacity is moderate. The organic matter content is moderately low. Runoff is slow. The water intake rate is high.

Most of the acreage of this unit supports native grasses used for grazing. The rest is used mainly for dryland farming.

If dryland farmed, this soil is suited to small grains, alfalfa, and introduced grasses. Inadequate rainfall in summer generally limits the cultivated crops that can be grown. Soil blowing is the principal hazard in areas where the surface is not adequately protected by crops or crop residue. A system of conservation

tillage, such as stubble mulching and ecofallow, that keeps crop residue on the surface helps to control soil blowing and water erosion and conserve soil moisture. Stripcropping and annual cover crops help to control soil blowing. Returning crop residue to the soil helps to maintain the organic matter content and fertility and improves the water intake rate. Summer fallowing conserves soil moisture for use during the following growing season.

If irrigated by a sprinkler system, this soil is suited to corn, field beans, sugar beets, small grains, alfalfa, and introduced grasses. This soil is not suited to gravity irrigation systems because of the sandy surface layer and the high water intake rate. Soil blowing is the principal hazard. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue into the soil helps improve the organic matter content and fertility. The efficient use of irrigation water is a management concern because excessive amounts of water leach plant nutrients below the root zone.

If this soil is used for range or native hay, the climax vegetation is dominantly prairie sandreed, blue grama, threadleaf sedge, and little bluestem. These species make up 75 percent or more of the total annual forage. Sand bluestem, needleandthread, switchgrass, sand lovegrass, western wheatgrass, sideoats grama, and forbs make up the rest.

If the range is in excellent condition, the suggested initial stocking rate is 0.7 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If this soil is used as hayland, the forage should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range. Mowing should be regulated so that the grasses remain healthy and vigorous.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and soil blowing are the main hazards affecting young trees. Irrigation can provide supplemental moisture during periods of low rainfall. Soil blowing can be controlled by maintaining strips of sod or a cover crop between the tree rows. Cultivation between the rows

with conventional equipment can control the undesirable grasses and weeds in areas where strips of sod and cover crops are not used. The weeds and undesirable grasses in the tree rows can be controlled by the careful use of the appropriate kind of herbicide or hoeing by hand.

This soil is generally suited to septic tank absorption fields, dwellings, and building sites. A good surface drainage system can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. The sides of shallow excavations in this soil can cave in unless they are shored.

The land capability units are 111e-5, dryland, and 111e-10, irrigated; Sandy range site; and windbreak suitability group 5.

**Vt—Vetal fine sandy loam, 0 to 2 percent slopes.**

This very deep, nearly level, well drained soil is on foot slopes and in upland swales. It formed in loamy and sandy alluvium and eolian sediments. Areas range from 5 to 250 acres in size.

Typically, the surface layer is dark gray, very friable fine sandy loam about 7 inches thick. The subsurface layer is very friable fine sandy loam about 24 inches thick. The upper part is dark gray, and the lower part is dark grayish brown. The transitional layer is grayish brown, very friable fine sandy loam about 12 inches thick. The underlying material is light gray, calcareous fine sand to a depth of 60 inches or more. In some places the surface layer is loamy very fine sand or very fine sandy loam. In other places the dark surface soil is less than 20 inches thick.

Included with this soil in mapping are small areas of Dailey, Jayem, and Tuthill soils. Dailey soils have more sand in the profile than the Vetal soil and are higher on the landscape. Jayem soils have a dark surface soil less than 20 inches thick and are higher on the landscape than the Vetal soil. Tuthill soils have more silt and clay in the upper part of the profile than the Vetal soil and are higher on the landscape. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Vetal soil. Available water capacity is moderate. The organic matter content is moderately low. Runoff is slow. The water intake rate is moderately high.

Most of the acreage of this soil is dryland farmed. The rest mainly supports native grasses used for grazing and haying.

If dryland farmed, this soil is suited to small grains, alfalfa, and introduced grasses. Inadequate rainfall in summer generally limits the cultivated crops that can be grown. Soil blowing is the principal hazard in areas

where the surface is not protected by crops or crop residue. A system of conservation tillage, such as stubble mulching and ecofallow, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. Cover crops also help to control soil blowing. Returning crop residue to the soil helps to maintain the organic matter content and fertility and improves the water intake rate.

If irrigated, this soil is suited to corn, field beans, small grains, alfalfa, and introduced grasses. It is suited to sprinkler and gravity irrigation systems. Some land leveling is generally needed for gravity systems to ensure the uniform distribution of water. Soil blowing is the principal hazard. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil blowing and conserve soil moisture. The use of cover crops during the winter also helps to control soil blowing. Incorporating crop residue into the soil improves the organic matter content and fertility. The efficient use of water is a management concern because excessive amounts of water can leach plant nutrients from the soil.

This soil is suited to introduced grasses used as pasture and hayland. These grasses can be rotated with crops. Such cool-season grasses as pubescent wheatgrass and intermediate wheatgrass can be seeded either alone or in a mixture with warm-season grasses, such as switchgrass or big bluestem, on dryland pasture and hayland. Such cool-season grasses as smooth brome or orchardgrass can be seeded either alone or in a mixture with legumes, such as alfalfa or cicer milkvetch, into irrigated pastures. Fertilization improves the growth and vigor of the grasses. Weeds can be controlled if the appropriate kind of herbicide is applied.

This soil is suited to range. A cover of range plants effectively controls soil blowing. Continuous heavy grazing by livestock or improper haying reduces the amount of protective cover and the quality of the native plants. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the condition of the native plants.

This soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and soil blowing are the main hazards affecting young trees. Irrigation can provide supplemental moisture during periods of low rainfall. Soil blowing can be controlled by maintaining strips of sod or cover crops between the tree rows. Cultivating between the rows with conventional equipment can control grasses and weeds in areas where strips of sod and cover crops are not used. The undesirable grasses and weeds in

the tree rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide.

This soil is generally suited to septic tank absorption fields, dwellings, and buildings. A surface drainage system minimizes the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. The sides of shallow excavations can cave in unless they are shored.

The land capability units are 11e-3, dryland, and 11e-8, irrigated; Sandy range site; and windbreak suitability group 5.

**WrB—Wildhorse fine sand, 0 to 3 percent slopes.** This very deep, nearly level and very gently sloping, somewhat poorly drained soil is in sandhill valleys. It formed in eolian sand and sandy alluvium. Areas range from 20 to 300 acres in size.

Typically, the surface layer is grayish brown, very friable, calcareous, very strongly alkaline fine sand about 5 inches thick. The transitional layer is light brownish gray, calcareous, very strongly alkaline fine sand about 5 inches thick. The underlying material extends to a depth of 60 inches or more. It is light brownish gray, calcareous, very strongly alkaline fine sand in the upper part; light gray, calcareous, very strongly alkaline, mottled fine sand in the middle part; and light gray, strongly alkaline, mottled fine sand in the lower part. In some places the surface layer is loamy fine sand.

Included with this soil in mapping are small areas of Els, calcareous; Hoffland; Ipage; and Valent soils. The included soils are not high in content of sodium. Els, calcareous, soils are on similar landscapes as the Wildhorse soil. Hoffland soils are high in carbonates and are lower on the landscape than the Wildhorse soil. Ipage and Valent soils are better drained than the Wildhorse soil and are higher on the landscape. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Wildhorse soil. Available water capacity and organic matter content are low. Runoff is slow. The seasonal high water table ranges from a depth of 1.5 feet during wet years to 3.5 feet during dry years. The water table normally recedes to a depth of 4 or 5 feet in late summer. This soil has a high content of sodium.

All of the acreage of this soil supports native grasses used for grazing or haying.

This soil is not suited to farming because it has a high content of sodium.

If this soil is used as range or hayland, the climax vegetation is dominantly alkali sacaton, inland saltgrass, western wheatgrass, slender wheatgrass,

and switchgrass. These species make up 70 percent or more of the total annual forage. Foxtail barley, bluegrass, sedges, and forbs make up the rest. If subject to continuous heavy grazing or improperly harvested for hay, alkali sacaton, western wheatgrass, and switchgrass decrease in abundance and are replaced by inland saltgrass, blue grama, bluegrass, foxtail barley, sand dropseed, and alkali tolerant sedges. If overgrazing or improper haying continues for many years, inland saltgrass, blue grama, bluegrass, foxtail barley, alkali tolerant sedges, rushes, and forbs dominate the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. The alkalinity of the soil limits forage production and greatly influences the kinds of plants that grow. In some areas the very strongly alkaline soils support little or no vegetation and are subject to a severe hazard of soil blowing during dry periods. Careful management is needed to maintain the plant cover.

If this soil is used as hayland, mowing should be regulated so that the grasses remain vigorous.

This soil is not suited to the trees and shrubs planted in windbreaks because it has a high content of sodium. A few areas may be suitable for the trees or shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used.

Constructing septic tank absorption fields on fill material raises the fields a sufficient distance above the seasonal high water table. This soil readily absorbs but does not adequately filter the effluent from the absorption fields. The poor filtering capacity of this soil can result in pollution of the ground water. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving if the excavation is made during dry periods. Constructing dwellings and buildings on raised, well compacted fill material helps to overcome the wetness caused by the high water table and helps to prevent the damage caused by ponding. Constructing roads on suitable, well compacted fill material, providing adequate side ditches, and installing culverts help protect roads from the damage resulting from the wetness caused by the seasonal high water table. A good surface drainage system and a gravel moisture barrier in the subgrade can minimize the damage to roads caused by frost

action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

The land capability unit is VIs-1, dryland; Saline Subirrigated range site; and windbreak suitability group 10.

**WsB—Wildhorse-Hoffland complex, 0 to 3 percent slopes.** These soils are in sandhill valleys.

The Wildhorse soil is very deep, nearly level and very gently sloping, and somewhat poorly drained, and the Hoffland soil is very deep, nearly level, and poorly drained. The Wildhorse soil formed in eolian sand and sandy alluvium, and the Hoffland soil formed in sandy alluvium. The Wildhorse soil is on the very gently sloping ridges, and the Hoffland soil is in the nearly level, low areas between the ridges (fig. 15). The Hoffland soil is subject to rare flooding. Areas range from 20 to 900 acres in size. They consist of 55 to 70 percent Wildhorse soil and 25 to 40 percent Hoffland soil. These soils are so intermingled or mixed that separating them in mapping is not practical.

Typically, the Wildhorse soil has a surface layer of light brownish gray, very friable, calcareous, very strongly alkaline fine sand about 6 inches thick. The underlying material is calcareous, very strongly alkaline fine sand to a depth of 60 inches or more. It is grayish brown in the upper part, light brownish gray in the middle part, and light brownish gray and mottled in the lower part. In some places the surface layer is loamy fine sand.

Typically, the Hoffland soil has a surface layer of gray, very friable, calcareous fine sandy loam about 4 inches thick. The subsurface layer is very friable, calcareous fine sandy loam about 7 inches thick. The upper part is gray, and the lower part is light brownish gray. The underlying material is light brownish gray and light gray fine sand to a depth of 60 inches or more. It is mottled in the upper part. In some places the surface layer is loam. In a few places the profile is calcareous throughout.

Included with these soils in mapping are small areas of Els, calcareous; lpage; and Marlake soils. The included soils are not high in content of sodium. Els, calcareous, soils are on similar landscapes as the Wildhorse soil. lpage soils are better drained than the Wildhorse and Hoffland soils and are slightly higher on the landscape. Marlake soils are very poorly drained and are lower on the landscape than the Wildhorse and Hoffland soils. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Wildhorse and Hoffland soils. The Wildhorse soil has low available water capacity and low organic matter content. The Hoffland



Figure 15.—A typical area of Wildhorse-Hoffland complex, 0 to 3 percent slopes. The nearly level Hoffland soil is on the lowest parts of the landscape. The Wildhorse soil is slightly higher on the landscape between areas of the Hoffland soil.

soil has low available water capacity and very high organic matter content. Runoff is slow on the Wildhorse soil and very slow on the Hoffland soil. The Wildhorse soil has a seasonal high water table that ranges from a depth of 1.5 feet during wet years to 3.5 feet during dry years. The Hoffland soil has a seasonal high water table that ranges from the surface during wet years to a depth of 1.5 feet during dry years. The Wildhorse soil has a high content of sodium.

These soils are used as rangeland and hayland.

These soils are not suited to use as cropland because of the high content of sodium in the Wildhorse soil and the wetness caused by the seasonal high water table in the Hoffland soil.

If these soils are used as range or hayland, the climax vegetation on the Wildhorse soil is dominantly

alkali sacaton, inland saltgrass, western wheatgrass, slender wheatgrass, and switchgrass. These species make up 70 percent or more of the total annual forage. Foxtail barley, bluegrass, sedges, and forbs make up the rest. The climax vegetation on the Hoffland soil is dominantly big bluestem, indiangrass, prairie cordgrass, switchgrass, sedges, and rushes. These species make up 60 percent or more of the total annual forage. Bluegrass, slender wheatgrass, and forbs make up the rest. If subject to continuous heavy grazing or improperly harvested for hay, alkali sacaton, western wheatgrass, and switchgrass decrease in abundance on the Wildhorse soil and big bluestem, prairie cordgrass, switchgrass, and indiangrass decrease in abundance on the Hoffland soil. They are replaced by inland saltgrass, blue grama, bluegrass,

foxtail barley, sand dropseed, and alkali tolerant sedges on the Wildhorse soil and slender wheatgrass, western wheatgrass, plains muhly, and sedges on the Hoffland soil. Timothy, redtop, and red clover also increase in abundance if they have been overseeded. If overgrazing or improper haying continues for many years, inland saltgrass, blue grama, bluegrass, foxtail barley, alkali tolerant sedges, rushes, and forbs dominate the site on the Wildhorse soil, and bluegrass, western wheatgrass, sedges, rushes, and forbs dominate the site on the Hoffland soil.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre on the Wildhorse soil and 1.8 animal unit months per acre on the Hoffland soil. The stocking rate is determined by the percentage of each soil in the pasture. The range should be closely monitored during use and the stocking rates adjusted so that one soil does not become overgrazed. A planned grazing system that includes proper grazing use and timely deferments from grazing and haying helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities can result in a more uniform distribution of grazing. The alkalinity on the Wildhorse soil limits forage production and greatly influences the kinds of plants that grow. In some areas the very strongly alkaline soils support little or no vegetation and are subject to a severe hazard of soil blowing during dry periods. Careful management is needed to maintain the plant cover. During wet periods on the Hoffland soil, grazing and operating heavy machinery cause surface compaction and the formation of small mounds and ruts, which make grazing or harvesting hay difficult.

If these soils are used as hayland, mowing should be regulated so that the grasses remain vigorous. Large meadows can be divided into three sections and the sections mowed in rotation. The order in which the sections are mowed should be changed in successive years. After the ground is frozen, livestock can graze the Hoffland soil without damaging the meadows. They should be removed in the spring before the ground thaws and the water table reaches a high level.

The Wildhorse soil is generally not suited to the trees and shrubs planted in windbreaks because it has a high content of sodium. A few areas may be suitable for the trees or shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used. The Hoffland soil is suited to the trees and shrubs planted in windbreaks. The main limitation affecting the establishment of windbreaks is the wetness caused by the high water table. The species suitable for planting are those that can

withstand the occasional wetness. Tilling and planting seedlings should be delayed until after the soil has begun to dry. Seedlings can survive and grow if competing vegetation between the tree rows is controlled by cultivation with conventional equipment. The undesirable grasses and weeds in the rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide.

The Hoffland soil is not suited to septic tank absorption fields and building sites because of the wetness and the flooding. A suitable alternative site should be selected. In areas of the Wildhorse soil, constructing septic tank absorption fields on fill material raises the fields a sufficient distance above the seasonal high water table. The Wildhorse soil readily absorbs but does not adequately filter the effluent from septic tank absorption fields. The poor filtering capacity can result in pollution of the ground water. Constructing dwellings and buildings on raised, well compacted fill material helps to overcome the wetness caused by the high water table and the rare flooding in areas of the Hoffland soil. Constructing roads on suitable, well compacted fill material, providing adequate side ditches, and installing culverts help protect roads from the damage caused by the wetness and the flooding. A good surface drainage system and a gravel moisture barrier in the subgrade can minimize the damage to roads caused by frost action in areas of the Wildhorse soil. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

The land capability units are VIs-1, dryland, for the Wildhorse soil and Vw-7, dryland, for the Hoffland soil. The Wildhorse soil is in the Saline Subirrigated range site and windbreak suitability group 10. The Hoffland soil is in the Wet Subirrigated range site and windbreak suitability group 2D.

**WtB—Wildhorse-lpage, calcareous complex, 0 to 3 percent slopes.** These soils are in sandhill valleys. The Wildhorse soil is very deep, nearly level, and somewhat poorly drained, and the lpage, calcareous, soil is very deep, very gently sloping, and moderately well drained. The Wildhorse soil formed in sandy alluvium and eolian sand. The lpage, calcareous, soil formed in eolian sand. Areas range from 20 to 300 acres in size. They consist of 55 to 65 percent Wildhorse soil and 30 to 40 percent lpage, calcareous, soil. These soils are so intermingled or mixed that separating them in mapping is not practical.

Typically, the Wildhorse soil has a surface layer of dark grayish brown, very friable, calcareous, very

strongly alkaline fine sand about 6 inches thick. The transitional layer is grayish brown, very friable, calcareous, very strongly alkaline loamy fine sand about 5 inches thick. The underlying material is calcareous, very strongly alkaline and strongly alkaline fine sand to a depth of 60 inches or more. It is light brownish gray and mottled in the upper part and grayish brown in the lower part. In some places the surface layer is loamy fine sand.

Typically, the lpage, calcareous, soil has a surface layer of dark gray, loose, calcareous fine sand about 6 inches thick. The transitional layer is grayish brown, loose, calcareous fine sand about 8 inches thick. The underlying material is light gray, calcareous fine sand to a depth of 60 inches or more. In some areas the dark surface layer is more than 10 inches thick. In some places the surface layer is sand, loamy sand, or loamy fine sand. In other places the underlying material is stratified. In some areas the upper part of the profile is noncalcareous.

Included with these soils in mapping are small areas of Hoffland and Valent soils. Hoffland soils are poorly drained and are in low areas. Valent soils are excessively drained and are higher on the landscape than the Wildhorse and lpage, calcareous, soils. Included soils make up 5 to 15 percent of the unit.

Permeability is rapid in the Wildhorse and lpage, calcareous, soils. Both soils have low available water capacity and low organic matter content. Runoff is slow. The water intake rate is very high. The Wildhorse soil has a seasonal high water table that ranges from a depth of 1.5 feet during wet years to 3.5 feet during dry years. The lpage, calcareous, soil has a seasonal high water table that ranges from a depth of 3 feet during wet years to 5 feet during dry years. The Wildhorse soil has a high content of sodium.

Nearly all of the acreage of these soils support native grasses used for grazing or haying. In a few cultivated areas sprinkler irrigation systems are used.

These soils are not suited to dry-farmed crops because of the high content of sodium in the Wildhorse soil and the droughtiness and the hazard of soil blowing in the lpage, calcareous, soil.

The Wildhorse soil is not suited to irrigated crops because of the high content of sodium.

If irrigated by a sprinkler system, the lpage, calcareous, soil is poorly suited to corn, alfalfa, and introduced grasses. It is too sandy for gravity irrigation systems. Because of the low available water capacity, frequent, light applications of irrigation water are needed. Soil blowing is a severe hazard if the surface is not protected by crops or crop residue. A system of conservation tillage, such as ecofallow and no-till, that keeps crop residue on the surface helps to control soil

blowing and conserve soil moisture. The use of cover crops during the winter helps to control soil blowing. Returning crop residue to the soil helps improve organic matter content and fertility. The efficient use of irrigation water is a management concern because the applications of excessive amounts of water can leach plant nutrients.

If these soils are used as range or hayland, the climax vegetation on the Wildhorse soil is dominantly alkali sacaton, inland saltgrass, western wheatgrass, slender wheatgrass, and switchgrass. These species make up 70 percent or more of the total annual forage. Foxtail barley, bluegrass, sedges, and forbs make up the rest. The climax vegetation on the lpage, calcareous, soil is dominantly sand bluestem, little bluestem, prairie sandreed, needleandthread, and switchgrass. These species make up 75 percent or more of the total annual forage. Blue grama, prairie junegrass, bluegrass, indiangrass, sedges, and forbs make up the rest. If subject to continuous heavy grazing or improperly harvested for hay, alkali sacaton, western wheatgrass, and switchgrass decrease in abundance on the Wildhorse soil and sand bluestem, indiangrass, little bluestem, and switchgrass decrease in abundance on the lpage, calcareous, soil. They are replaced by inland saltgrass, blue grama, bluegrass, foxtail barley, sand dropseed, and alkali tolerant sedges on the Wildhorse soil and prairie sandreed, needleandthread, sand dropseed, blue grama, sedges, and forbs on the lpage, calcareous, soil. If overgrazing or improper haying continues for many years, inland saltgrass, blue grama, bluegrass, foxtail barley, alkali tolerant sedges, rushes, and forbs dominate the site on the Wildhorse soil, and blue grama, sand dropseed, needleandthread, Scribner panicum, sedges, and forbs dominate the site on the lpage, calcareous, soil. Under these conditions the native plants lose vigor and are unable to stabilize the site.

If the range is in excellent condition, the suggested initial stocking rate is 0.9 animal unit month per acre. The range should be closely monitored during use and the stocking rates adjusted so that one soil does not become overgrazed. A planned grazing system that includes proper grazing use, timely deferments from grazing and haying, and restricted use during wet periods helps to maintain or improve the range condition. Properly located fences and livestock watering and salting facilities result in a more uniform distribution of grazing. Areas previously used as cropland should be reseeded to a suitable grass mixture if they are used as range.

If these soils are used as hayland, mowing should be regulated so that the grasses remain vigorous. The

forage on the lpage, calcareous, soil should be harvested only every other year. During the year the forage is not harvested, the hayland should be used only as fall or winter range.

The Wildhorse soil is not suited to the trees and shrubs planted in windbreaks because it has a high content of sodium. A few areas may be suitable for the trees or shrubs that enhance recreational areas and wildlife habitat and for forestation if the tolerant species are planted by hand or if other special management is used. The lpage, calcareous, soil is suited to the trees and shrubs planted in windbreaks. The lack of adequate seasonal rainfall and soil blowing are the main hazards affecting young trees. Irrigation can provide supplemental moisture during periods of low rainfall. Because the soil is loose, trees should be planted in shallow furrows with as little disturbance of the soil as possible. Strips of sod or other vegetation is needed between the tree rows to control soil blowing. Seedlings can be damaged by high winds and covered by drifting sand. The undesirable grasses and weeds in the tree rows can be controlled by hoeing by hand, rototilling, or the careful use of the appropriate kind of herbicide.

Constructing septic tank absorption fields on fill material raises the fields a sufficient distance above

the seasonal high water table. The poor filtering capacity can result in pollution of the ground water. These soils readily absorb but do not adequately filter the effluent from septic tank absorption fields. The lpage, calcareous, soil is generally suited to sites for dwellings and buildings without basements. Constructing dwellings with basements on the lpage, calcareous, soil and all building sites on the Wildhorse soil on raised, well compacted fill material helps to overcome the wetness caused by the high water table. A good surface drainage system and a gravel moisture barrier in the subgrade can minimize the damage to roads caused by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving if the excavation is made during dry periods.

The land capability units are VIs-1, dryland, for the Wildhorse soil and VIe-5, dryland, and IVe-12, irrigated, for the lpage, calcareous, soil. The Wildhorse soil is in the Saline Subirrigated range site and windbreak suitability group 10. The lpage, calcareous, soil is in the Sandy Lowland range site and windbreak suitability group 7.



## Prime Farmland

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

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

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The

slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service.

About 266,000 acres in the survey area, or nearly 17 percent of the total acreage, meets the soil requirements for prime farmland. Areas of this land are in the northern part of the county in associations 2, 4, 6, and 9, which are described under the heading "General Soil Map Units." The main crops grown on this land are corn, winter wheat, alfalfa, and dry, edible beans.

The map units in the survey area 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."

Soils that have hazards or limitations, such as a seasonal high water table, frequent flooding during the growing season, or an inadequate amount of rainfall, qualify as prime farmland only in areas where these hazards or limitations have been overcome by such measures as drainage, flood control, or irrigation. 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.



# Accessibility Statement

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