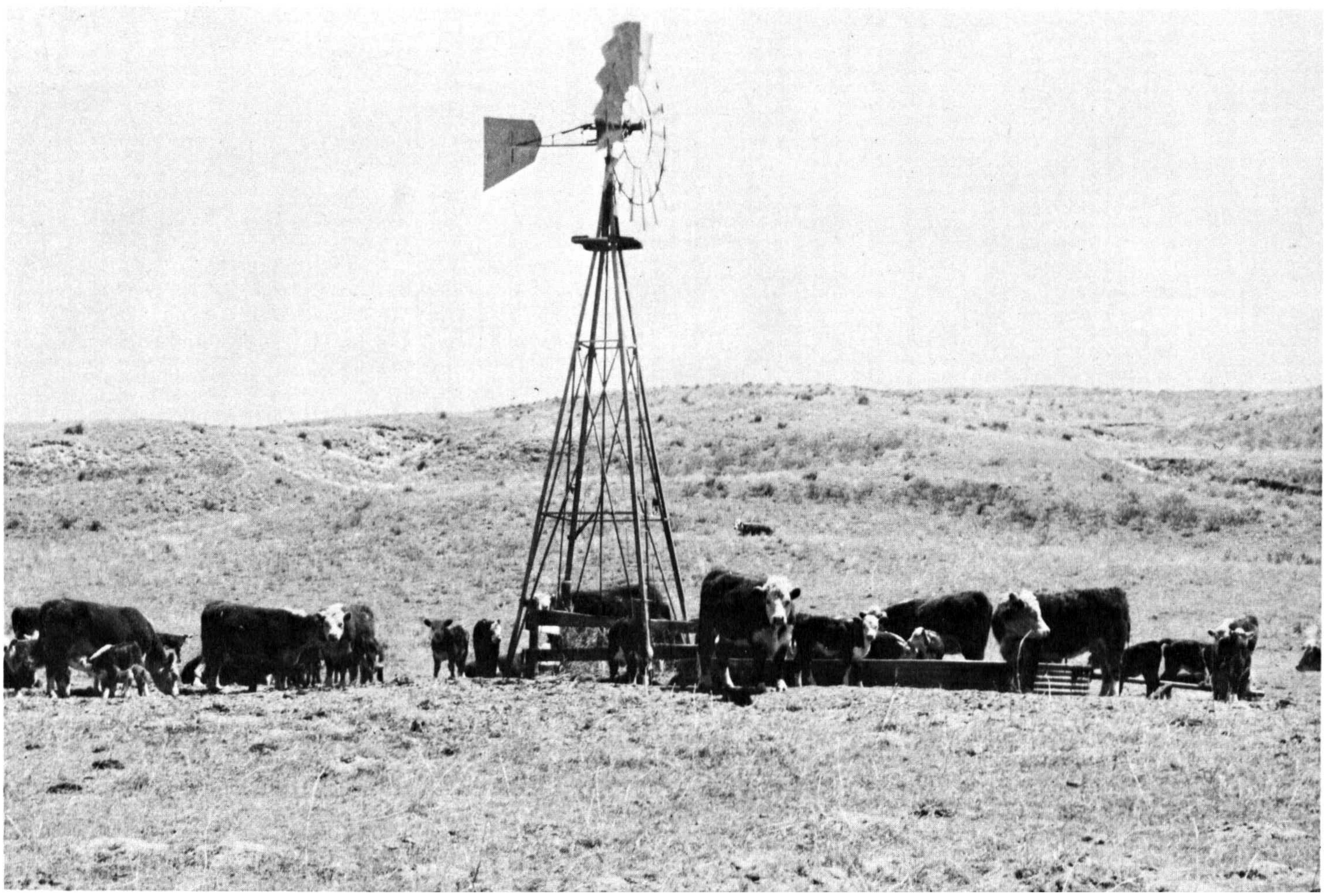
SOIL SURVEY OF

Arthur and Grant Counties, Nebraska



United States Department of Agriculture
Soil Conservation Service
In cooperation with the
University of Nebraska
Conservation and Survey Division

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all who need the information, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1968–73. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the counties in 1973. This survey was made cooperatively by the Soil Conservation Service and the University of Nebraska Conservation and Survey Division. It is part of the technical assistance furnished to the Twin Platte and Upper Loup Natural Resources Districts.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Arthur and Grant Counties are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the two counties in alphabetic order by map symbol and gives the capability classification, range site, and windbreak suitability group in which each soil has been placed. It shows the page where each soil is described and the page for the capability unit in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the capability units, the range sites, and the windbreak suitability groups.

Foresters and others can refer to the section "Use of the Soils for Windbreaks," where the soils of the county are grouped according to their suitability for trees.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Use of the Soils for Wildlife and Recreation."

Ranchers and others can find, under "Use of the Soils for Range," groupings of the soils according to their suitability for range, and also the names of many of the plants that grow on each range site.

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about soil formation and classification in the section "Formation and Classification of the Soils."

Newcomers in Arthur and Grant Counties may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the counties given in the section "Environmental Factors Affecting Soil Use."

Cover: Raising beef cattle is by far the largest single industry in Arthur and Grant Counties. This herd is in an area of Valentine soils.

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Issued November 1977

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SOIL SURVEY OF ARTHUR AND GRANT COUNTIES, NEBRASKA

By Donald A. Yost and Lester E. Sherfey, Soil Conservation Service

Soils surveyed by Lester E. Sherfey

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

ARTHUR AND GRANT COUNTIES are in the west-central part of Nebraska (fig. 1) Arthur County occupies the southern part of the survey area. It is 24 miles from north to south and 30 miles from east to west. The total area is about 704 square miles or a land area of about 450,624 acres. In 1970 the population was 606, all rural. Arthur is the county seat and principal town.

Grant County occupies the northern part of the survey area. It is 24 miles from north to south and 33 miles from east to west at the maximum points. Its area is about 764 square miles,or a land area of 488,960 acres. In 1970 the population was 1,019, all rural. Hyannis is the county seat and principal town.

Each county has a high school located in the county seat. Elementary schools are located where needed throughout the area. About one-half the enrollment is in those school districts that include Arthur and Hyannis. There are three churches in Arthur and three in Hyannis. These, with two country churches, provide religious and social services for residents of the area.

Service and social clubs are available in the area. School activities, rodeos, and horse shows are major sources of recreation. Excellent hunting and fishing are also readily available.

The climate of the survey area is characterized by light rainfall, cold winters, warm summers, and frequent changes in weather from day to day and from season to season. The soils of the area are mostly sandy and poorly suited to cultivated crops. Ranching, primarily producing feeder cattle, is the main enterprise. Breeding purebred cattle is also important.

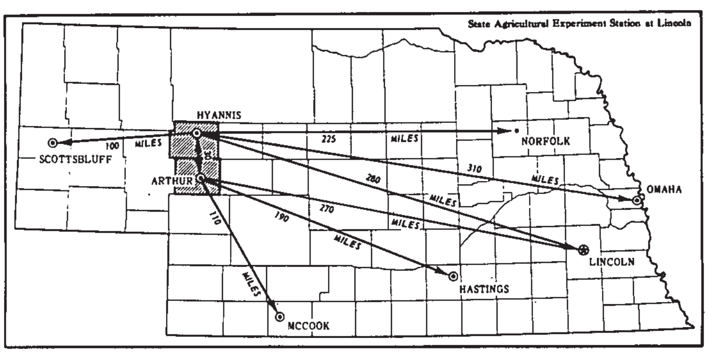

Figure 1.—Location of Arthur and Grant Counties in Nebraska.

The survey area is composed mainly of stabilized eolian sands. The landscape consists of long ranges of rolling or hilly dunes alternating with long, nearly level to gently rolling valleys. Most all the rolling and hilly areas are composed of excessively drained sandy soils.

Nearly all the survey area is in native grass and used for grazing. Many areas are in wet valleys and have a high or moderately high water table. They are mostly in native grass and are used mainly for hay. A few areas are in dry valleys where the soils are well drained. These soils provide most of the sites for the limited acreage of cultivated crops.

The presence of arrowheads and other artifacts throughout Arthur and Grant Counties indicates that Indians hunted here and probably had semipermanent settlements in the survey area centuries before the later settlers arrived. Cattlemen first settled in the area in the 1870's. They grazed their cattle on government-owned range until after the turn of the century. In 1887 the Chicago, Burlington, and Quincy (now Burlington Northern) Railroad built a line through the northern part of the survey area. At about the same time, the Union Pacific Railroad built a line about 20 miles south of the area. This encouraged homesteading, which progressed slowly however until after the Kinkaid Act passed in 1904. This act increased to 640 acres the amount of land a homesteader could acquire. Population of the survey area increased to 2,898 by 1920.

Most settlers in Arthur and Grant Counties were farmers from the south and east. They plowed many of the valleys to produce grain, and they milked cows that grazed the hills in summer and that wintered on hay from the valleys. The combination of low rainfall and sandy soils soon convinced the settlers that even 640 acres was not sufficient to produce an adequate income. Many sold out to their neighbors. From 1920 to 1970, the population in the survey area has gradually decreased. As the population decreased, the size of the ranches increased. In 1970 the population of the survey area was 1,635, and the average ranch size was 6,439 acres in Arthur County and 10,414 in Grant County.

As individual land holdings increased, the acreage in cultivated crops decreased and raising range cattle easily became the major enterprise. Grant County apparently made a more rapid transition to a ranching economy than Arthur County. No cultivated crops have been reported in Grant County since before 1950; its population increased by 10 during the 1960's. There were 1,770 acres of cultivated crops in Arthur County in 1960 and 340 acres in 1970; its population decreased by 74 during this 10-year period. In 1970 in the survey area, 643 people lived on ranches, and the other 982 residents lived in the towns of Arthur, Ashby, Hyannis, and Whitman.

Ranches in Arthur and Grant Counties are organized in widely different ways. How a particular ranch is organized depends on the desires of the operator and the combination of different soils in the ranching unit. Basically, each rancher has a herd of cows that produces calves. The calves are sold as feeder cattle or for breeding purposes. On some ranches calves born in the spring are sold in the fall. On other ranches such calves are kept through the winter and sold as yearlings. On a few ranches the calves are carried over another year and sold as 2-year-olds. The sale of older animals permits more winter grazing and is better suited to those ranch operations where labor or hay is scarce.

A successful ranch operation depends on keeping operating costs low. Sandhill ranchers early recognized the need for developing and using machinery and for employing other practices that save labor. Consequently they use the latest labor-saving power and equipment. Most ranches have telephones, television sets, and home freezers. Production testing is practiced by several ranchers. Insect control is practiced on most ranches. Prairie fires, formerly a serious hazard to all residents, are brought under better control today through the practice of fire prevention, through the use of modern fire-fighting equipment and through the promotion of greater cooperation between ranchers and people who live in the small communities of the two counties.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Arthur and Grant Counties, where they are located, and how they can be used. The soil scientists went into the counties knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and nature of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* is the category of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Elsmere and Valentine, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Valentine fine sand, 0 to 3 percent slopes, is one of several phases within the Valentine series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Arthur and Grant Counties: soil complexes and undifferentiated soil groups.

A soil complex consists of areas of two or more soils, so intricately mixed that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Gannett-Loup fine sandy loams, 0 to 2 percent slopes, is an example.

An undifferentiated soil group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. If there are two or more dominant series represented in the group, the name of the group ordinarily consists of the names of the dominant soils joined by "and." Doger and Dunday loamy fine sands, 0 to 3 percent slopes, is an undifferentiated soil group in Arthur and Grant Counties.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so saline or alkaline, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Saline-Alkali land is a land type in this survey.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all arable soils.

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants, as material for structures, as foundations for structures, or as covering for structures. They relate such behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or its high water table. They see that streets, road pavements, and foundations for houses are cracked on a particular soil, and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observations and knowledge of soil properties, together with available research data, to predict the limitations or suitability of a soil for present and potential uses.

After data have been collected and tested for the key soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultations. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Arthur and Grant Counties. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, a wildlife area, or in planning engineering works, recreational facilities, or other community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The terms for texture used in the descriptive headings for the associations apply to the texture of the surface layer. For example, in the description of the Valentine-Gannett-Elsmere association, the words sandy and loamy refer to the texture of the surface layer.

Soil association names and delineations on the general soil map do not fully agree with those of the general soil maps in soil surveys published at different dates for adjacent counties. Differences in the maps are the result of improvements in classification or of refinements in soil series concepts. Also, more precise maps are needed because the uses of the general soil map have expanded in recent years. The more modern maps meet this larger need.

The soil associations in Arthur and Grant Counties are described in the following pages.

1. Valentine-Gannett-Elsmere Association

Deep, nearly level to very steep, excessively drained to very poorly drained sandy and loamy soils on sandhills and in wet valleys

This association consists of long ranges of hills alternating with long valleys (fig. 2). These are generally oriented in an east-west direction. The hills range up to 400 feet above the valley floors. The hills in the southern part of the ranges are highest, steepest, and roughest. Their slopes are choppy with catsteps and rough, steep landscapes. Cup-shaped hollows are common in some areas. The hills become progressively lower, more rounded, and smoother in the northern part of the ranges. Most valleys are nearly level or very gently sloping. They are beaded with lakes that are commonly surrounded by narrow bands of Marsh and progressively better drained soils (fig. 3).

This soil association occupies about 36 percent of the survey area. About 77 percent of the association is made up of Valentine soils, 7 percent of Gannett soils, and 6 percent of Elsmere soils. The remaining 10 percent is composed of minor soils, land types, and lakes.

Valentine soils are deep, excessively drained, sandy soils. They range from nearly level to hilly, but most areas are rolling or hilly. They are mainly in the sandhills part of the landscape, though some areas occupy dry valleys where the water table is deep. The surface layer is dark grayish-brown, loose fine sand. Beneath this is a transition layer of grayish-brown fine sand. The underlying material is light brownish-gray fine sand.

Gannett soils are deep, poorly drained and very poorly drained soils that are nearly level. They are on bottom lands and on lower elevations of valley sides. The surface layer is friable, very dark gray and dark-gray fine sandy loam, silt loam, and loamy fine sand. Beneath this is gray fine sand that is transitional to the light gray fine sand underlying material. In some places mottling occurs at depths of 12 to 30 inches. The water table is at a depth of 0 to 3 feet beneath the surface.

Elsmere soils are deep, somewhat poorly drained and are nearly level or very gently sloping. They are on bottom lands and the lower parts of valley sides. The surface layer is very friable, very dark grayish brown loamy fine sand. Beneath this is a transition layer of light brownish-gray loamy fine sand. The underlying material is pale-brown, mottled fine sand. The water table is at a depth of 3 to 5 feet beneath the surface.

Minor soils in this association are in the Loup, Tryon,

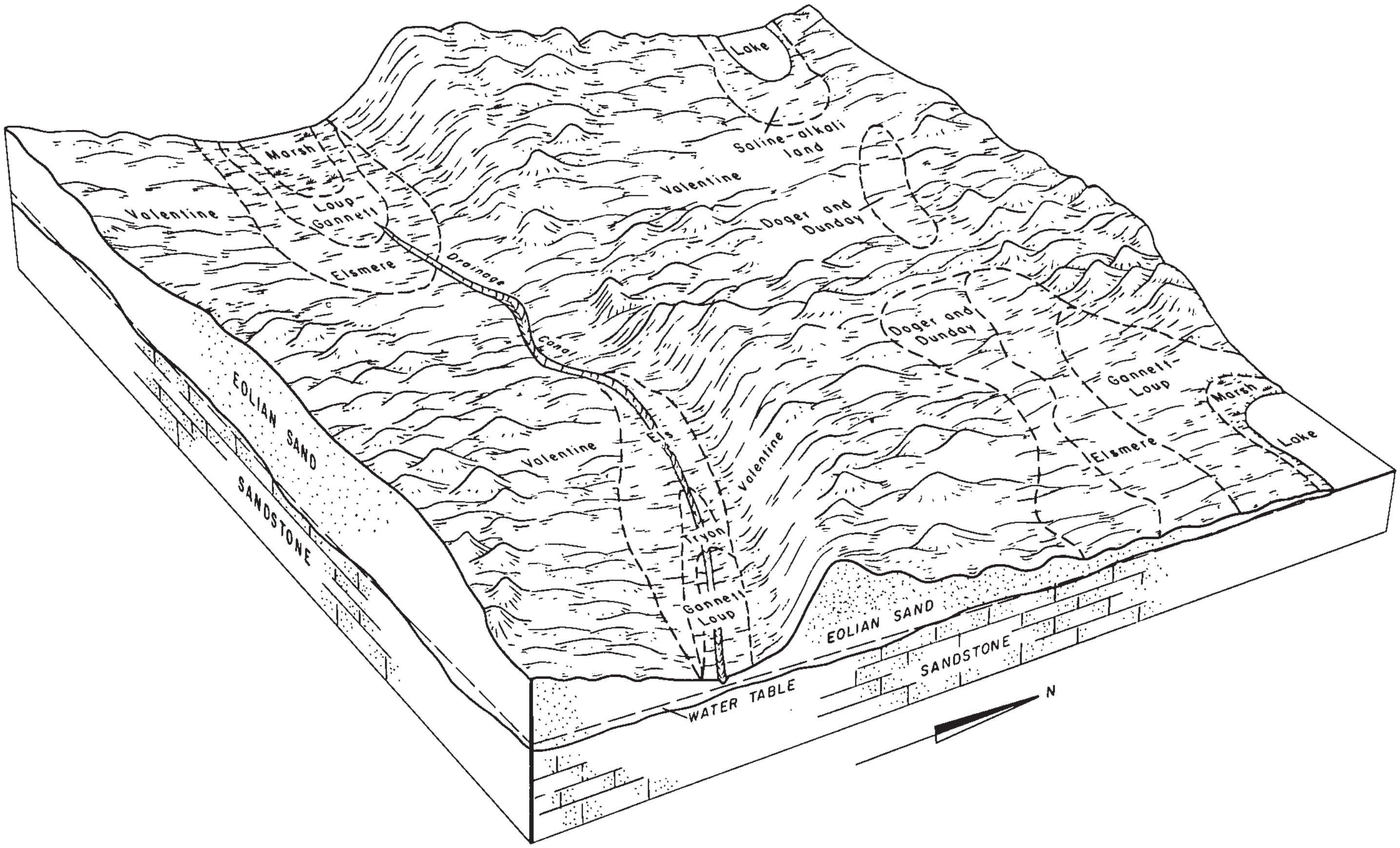

***Figure 2.*—Relationship of soils to parent material, bedrock, and water table in a typical area of the Valentine-Gannett-Elsmere association.**

Els, Doger, and Dunday series. Saline-Alkali land and Marsh are land types in this association. Lakes occupy the lowest parts of the landscape and mark the water table level of the area. Marsh occurs in low areas and borders the edges of some lakes. Loup soils, Tryon soils, and Saline-Alkali land are in wet valleys at slightly higher elevations than the adjacent Marsh. Els soils are in wet valleys at slightly higher elevations than the adjacent Loup, Tryon, and Gannett soils. Doger and Dunday soils are in dry valleys, lower than Valentine soils.

Soils in this association are used almost entirely for rangeland and hayland. The hayland is mainly in the wet valleys and the grazing land is on the hills, in the dry valleys, and on foot slopes. The major enterprise is raising feeder cattle. Raising purebred cattle for breeding is also important.

Good range management practices such as proper grazing use and planned grazing systems are a primary concern of ranchers in this soil association. A further concern is the shortage of summer grazing land. Most ranchers winter their cattle in this association and have most of their summer grazing land elsewhere. Some ranchers use cattle to graze meadowlands to lengthen their grazing season. The use of sprinkler systems for irrigation offers limited potential for producing more pasture and hayland. Few cultivated crops are grown in the area and the potential for increasing this acreage is limited.

Ranches in this association range in size from about 1,000 acres to over 50,000 acres. About 75 percent of the ranch headquarters in Arthur and Grant Counties are located in this association. Most are served by single-lane roads that are asphalt, gravel, or unimproved. Roads generally follow the valleys and wind through passes between the hills to avoid occasional steep grades and to avoid more expensive construction and maintenance. State Highways 2, 61, and 92 serve the residents of this association.

Rural elementary schools are widely separated. Hyannis and Arthur each have a high school.

Some of the cattle, mostly purebreds, are sold locally; some are trucked to nearby livestock auctions; and some are hauled by truck or rail to terminal markets in Omaha, Sioux City, and Denver.

2. Valentine Association

Deep, undulating to hilly, excessively drained sandy soils on sandhills and in swales

This association is made up of long ranges of hills alternating with narrow, dry swales and valleys. These are generally oriented in an east-west direction. The hills range up to 400 feet above the valley floors. The

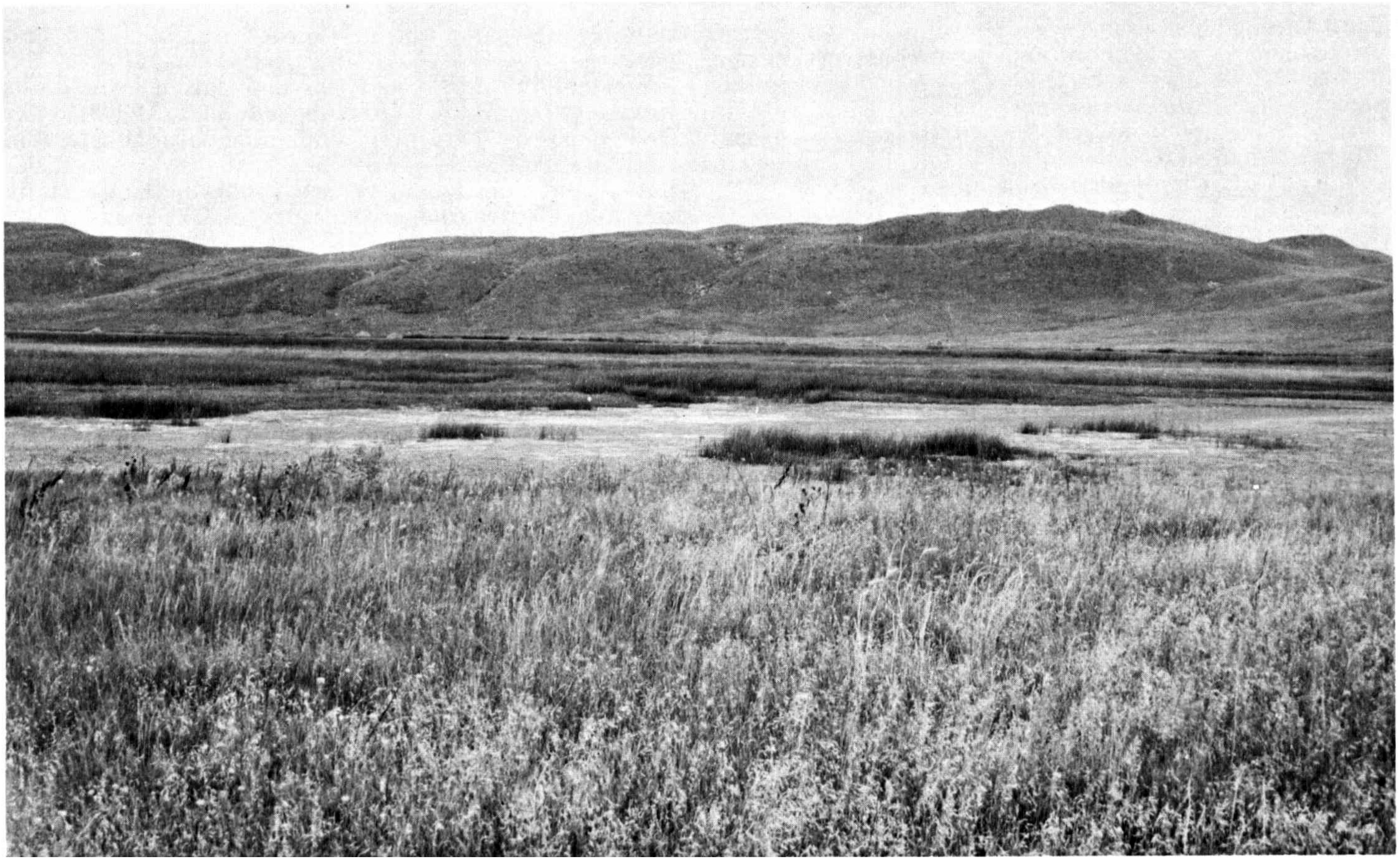

Figure 3.—**The soils in this wet valley are Elsmere and Gannett soils around a lake and area of Marsh. The rolling hills are Valentine soils.**

hills in the southern part of the ranges are higher, steeper, and rougher than those in the northern part. Their slopes are commonly choppy with catsteps and rough, steep landscapes. Cup-shaped hollows are common in some areas. The hills become progressively lower, more rounded, and smoother in the northern part of the ranges. Valleys are nearly level to gently sloping. Very few valleys are deep enough for the water table to influence vegetative growth.

This soil association occupies about 63 percent of the survey area. About 97 percent of the association is made up of Valentine soils. The other 3 percent is minor soils, land types, and lakes.

Valentine soils are deep, excessively drained, sandy soils. In this association they range from undulating to hilly. They occupy all but a few small areas in the deeper and wider valleys. The surface layer is loose, dark grayish-brown fine sand. The underlying material is light brownish-gray fine sand.

Minor soils in this association are in the Gannett, Els, Elsmere, Doger, and Dunday series. Marsh is a land type in the association. Small lakes occupy the lowest parts of a few of the deeper valleys, and the water surface marks the level of the water table in the area.

Marsh occurs in low areas and borders some of the lakes. Gannett soils are in wet valleys and at slightly higher elevations than Marsh or lakes. Elsmere and Els soils are in wet valleys at slightly higher elevations than Gannett soils. Doger and Dunday soils are on the bottoms and foot slopes of swales and dry valleys.

Most of the acreage of this association is in grass and is used for summer grazing. The largest of the subirrigated wet valleys and depressions are mowed for hay. Although the major enterprise is raising feeder cattle, raising purebred cattle for breeding is also important.

The installation of good range management practices, such as proper grazing and a planned grazing system, is a major concern of ranchers in this association. Another management concern is adjusting the stocking rate to the carrying capacity of the range. This problem is aggravated by the ready availability of cattle from nearby areas where there is excess hay. The use of sprinkler systems for irrigation offers limited potential for irrigated pasture. Few cultivated crops are grown in the area and the potential for their development is limited.

Most of the acreage of this association is used by ranchers who operate units that range in size from 1,000 acres to over 50,000 acres. Only about 15 percent of the ranch headquarters in the survey area are in this association. Roads are widely spaced and are mainly single lane. Surfaces are unimproved or are asphalt or gravel. Generally the roads follow the valleys, and they wind through passes between the hills to avoid steep grades and to avoid more expensive construction and higher maintenance costs. Only a few schools are in this association. Some cattle, mostly purebreds, are sold locally. Some are trucked to nearby livestock auctions; others are hauled by truck or rail to terminal markets in Omaha, Sioux City, and Denver.

3. Valentine-Doger-Dunday Association

Deep, nearly level to steep, excessively drained and well-drained sandy soils on sandhills and in dry valleys.

This association is made up of long ranges of hills alternating with long dry valleys. These ranges are generally oriented in an east-west direction. The crest of the hills range up to 250 feet above the valley floors. Steep rough areas are generally small and occur in the southern part of the ridges. Most of the ridges have a rolling to steep topography. The dry valleys are nearly level to gently rolling. The water table is deep and generally does not influence vegetative growth.

This association occupies only about 1 percent of the survey area. Valentine soils occupy about 91 percent of the association. About 7 percent is in soils of the Doger and Dunday series that are mapped together as an undifferentiated groups. The remaining 2 percent is made up of minor soils, land types, and lakes.

Valentine soils are deep, excessively drained, sandy soils. They range from nearly level to hilly, but most areas in this association are rolling. They occupy the ridges and more sloping parts of the valleys. The surface layer is dark grayish-brown, loose fine sand. Beneath this is grayish-brown, loose fine sand. The underlying material is light brownish-gray fine sand.

Doger soils are deep, well-drained, sandy soils. They range from nearly level to gently rolling, but most areas in this association are gently rolling. They occupy the ridges and the more sloping parts of the valleys. In most areas the surface layer is very friable, dark grayish-brown loamy fine sand. Beneath this is grayish-brown loamy fine sand. The underlying material is light brownish-gray loamy fine sand. In many places fine sandy loam material is at depths from 15 to 48 inches.

Dunday soils are deep, well-drained, sandy soils. The surface layer is very friable, dark grayish-brown loamy fine sand. Beneath this is a transition layer of grayish-brown loamy fine sand. The underlying material is grayish-brown loamy fine sand.

Minor soils in this association are the Gannett and Elsmere soils. Gannett soils are in the lower elevations of a few wet valleys. Elsmere soils are also in wet valleys, but at a slightly higher elevation than Gannett soils.

Grazing is the principal use for soils in this association. Most of the subirrigated depressions, which are not numerous in this association, are mowed for hay. The major enterprise is raising feeder cattle.

Installation of good range management practices, such as proper grazing use and a planned grazing system, is the major concern of ranchers in this association. The primary problem is balancing the supplies of summer and winter feed. There is a limited opportunity for increasing the acreage of cultivated crops. The use of sprinkler irrigation systems offers limited potential for increasing the acreage of irrigated hay and pasture.

Most of the acreage of this association is used for ranching. Units range from about 1,000 to 18,000 acres. Only about 10 percent of the ranch headquarters in Arthur and Grant Counties are located in this association. Ranch headquarters are generally supplied by single-lane roads of asphalt or gravel. The roads follow the valleys, and they wind through passes between the hills to avoid steep grades and to avoid more expensive construction and higher maintenance costs. Only a few schools are located in this association. Most cattle are sold at nearby livestock auctions, but some are hauled by truck to terminal markets in Omaha, Sioux City, and Denver.

Descriptions of the Soils

This section describes the soil series and mapping units in Arthur and Grant Counties. A soil series is described in detail, and then, briefly, each mapping unit in that series is described. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. Color terms are for dry soil unless otherwise stated. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Saline-Alkali land, for example, does not belong to a soil series, but it is listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol that identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the capability unit, range site, and windbreak suitability group in which the mapping unit has been placed. The page on which the description of each mapping unit is given can be found by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the "Glossary" at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual. (*5*) [1]

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[1] Italic numbers in parentheses refer to Literature Cited, p. 48.

TABLE 1.—*Approximate acreage and porportionate extent of the soils*

Soil	Arthur County		Grant County		Survey Area	
	Acres	Percent	Acres	Percent	Acres	Percent
Doger and Dunday loamy fine sands, 0 to 3 percent slopes	7,600	1.7	7,520	1.5	15,120	1.6
Doger and Dunday loamy fine sands, 3 to 9 percent slopes	1,150	.3	4.470	.9	5,620	.6
Doger and Dunday loamy fine sands, loamy substratum, 0 to 3 percent slopes	3,250	.8			3,250	.3
Els fine sand, 0 to 3 percent slopes	3,200	.7	4,670	1.0	7,870	.8
Els loamy fine sand, alkali, 0 to 3 percent slopes	980	.2	1,510	.3	2,490	.3
Elsmere loamy fine sand, 0 to 3 percent slopes	6,900	1.5	14,000	2.9	20,900	2.2
Gannett-Loup fine sandy loams, 0 to 2 percent slopes	3,850	.9	16,500	3.3	20,350	2.2
Gannett-Loup fine sandy loams, drained, 0 to 2 percent slopes	2,050	.5	3,820	.8	5,870	.6
Loup-Gannett loamy fine sands, 0 to 2 percent slopes	870	.2	1,450	.3	2,320	.2
Loup-Gannett loamy fine sands, drained, 0 to 2 percent slopes	150	([1])	820	.2	970	.1
Marsh	1,100	.2	2,850	.6	3,950	.4
Saline-Alkali land	414	.1	1,250	.3	1,664	.2
Tryon loamy fine sand, 0 to 2 percent slopes	240	.1	900	.2	1,140	.1
Tryon loamy fine sand, drained, 0 to 2 percent slopes	100	([1])	450	.1	550	.1
Valentine fine sand, 0 to 3 percent slopes	14,000	3.1	4,200	.9	18,200	1.9
Valentine fine sand, rolling	322,000	71.5	224,700	46.0	546,700	58.3
Valentine fine sand, rolling and hilly	74,000	16.3	162,500	33.1	236,500	25.2
Valentine fine sand, hilly	8,100	1.8	35,750	7.3	43,850	4.7
Water areas less than 40 acres in size	670	.1	1,600	.3	2,270	.2
Total land area	450,624	100.0	488,960	100.0	939,584	100.0
Water areas more than 40 acres in size	2,050		4,900		6,950	

[1] Less than 0.05 percent.

A given soil series in these counties may be identified by a different name in a recently published soil survey of an adjacent county. Some soils boundaries may not match adjoining areas. Such differences result from changes in concepts of soil classification that have occurred since publication.

Doger Series

This series consists of deep, nearly level to strongly sloping, well-drained soils. Some areas have complex slopes and are gently rolling. Doger soils are on uplands and on the bottoms of dry valleys. They formed in wind-deposited materials. Doger soils were mapped only with Dunday soils in this survey, and the two soils are not separated on the general soil map.

In a representative profile (fig. 4) the surface layer is very friable, dark grayish-brown loamy fine sand about 28 inches thick. Beneath this is a transition layer of grayish-brown loamy fine sand 9 inches thick. The underlying material is light brownish-gray loamy fine sand to a depth of 60 inches.

Doger soils have rapid permeability. The available water capacity is low to moderate in the loamy substratum phase. Organic-matter content is moderately low and natural fertility is low. Moisture is absorbed easily and released readily to plants.

Most areas of these soils are in native grass that is used for grazing or mowed for hay. Where the slope is not too steep, Doger soils are marginally suitable for dryland cultivated crops. They are suited also for irrigation, but a high level of management is needed for best results. Doger soils are suitable for trees and shrubs in windbreaks, and they provide nesting cover for game birds and food for larger wildlife species.

Representative profile of Doger loamy fine sand in an area of Doger and Dunday loamy fine sands, 3 to 9 percent slopes, in native grass, 528 feet north and 1,320 feet east of the southwest corner of the NW¼, sec. 28, T. 23 N., R. 38 W.:

A1—0 to 28 inches, dark grayish-brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; soft, very friable; many roots to a depth of 10 inches, common roots to depth of 28 inches; neutral; clear, wavy boundary.

AC—28 to 37 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; weak, fine, granular structure; soft, very friable; common roots; neutral; gradual, wavy boundary.

C—37 to 60 inches, light brownish-gray (10YR 6/2) loamy fine sand, grayish brown (10YR 5/2) moist; weak, fine, granular structure; soft, very friable; few roots; neutral.

The A horizon ranges from 20 to 40 inches thick, and the solum is 30 to 50 inches thick. Depth to fine sand ranges from 30 inches to more than 60 inches. The soil reaction ranges from neutral to mildly alkaline in all parts of the profile. The AC and C horizons are mainly loamy fine sand, but fine sandy loam is common in many areas.

Doger soils are near Valentine and Dunday soils. In some areas, however, they are near Elsmere and Gannett soils. They have a thicker A horizon than Valentine or Dunday soils, and they are better drained than Elsmere or Gannett soils.

Doger and Dunday loamy fine sands, 0 to 3 percent slopes (DdB).—These soils are on the bottoms of dry valleys and the lower parts of valley sides. Most areas of this mapping unit contain both Doger and Dunday soils in proportions that range from 10 to 90 percent for each soil. Some areas, however, consist entirely of Doger soil; other areas consist entirely of Dunday soil. Most areas have a higher proportion of Doger soil than

Figure 4.—**Profile of Doger loamy fine sand showing the very thick surface layer.**

Dunday soil. Doger soil is in the swales and Dunday soil is on low hammocks and valley sides.

The Doger soil in this unit has a profile similar to that described as representative of the series, but the surface layer is slightly thicker. The Dunday soil in this unit has the profile described as representative of the series. In this mapping unit are small areas that have underlying material of fine sandy loam.

Included with these soils in mapping were small areas of Valentine soils on ridges and hummocks or in places where erosion has thinned the surface layer. Also included were areas of Elsmere and Gannett soils in small depressions.

Soil blowing is a severe hazard, particularly where the vegetative cover is removed. The water intake rate is very high. The available water capacity is low. Runoff is slow, because most of the rainfall is absorbed almost as rapidly as it falls.

Most of the acreage of this unit is in native grass, which is used for grazing or mowed for hay. A small cultivated acreage responds favorably to good management, particularly to applications of nitrogen. A few areas are irrigated, mainly by sprinkler systems. Capability unit IVe–5; Sandy range site; windbreak suitability group 3.

Doger and Dunday loamy fine sands, 3 to 9 percent slopes (DdD).—These soils occupy mostly the lower slopes of uplands, merging with the dry valleys. Some areas are gently rolling. Most areas of this mapping unit contain both Doger and Dunday soils in proportions that range from 10 to 90 percent for each soil. Some small areas, however, consist entirely of Doger soil; other areas consist entirely of Dunday soil. Most areas have a higher proportion of Doger soil than Dunday soil. The Doger soil has a thicker surface layer than the Dunday soil.

The Doger soil in this unit has the profile described as representative for the series. The Dunday soil has a profile similar to that described as representative for the series, but the surface layer is slightly thinner. In this mapping unit are small areas of soils with underlying material of fine sandy loam.

Included with these soils in mapping were areas of Valentine soils on ridges and crests of hummocks.

Soil blowing is a severe hazard when the vegetative cover is removed. Water erosion is a hazard during rainfall of high intensity. The water intake rate is very high. The available water capacity is low. Runoff is medium, mainly because of the slope.

Nearly all the acreage of this unit is in native grass, which is used for grazing or mowed for hay. The soils are not suited to dryland cultivated crops because the erosion hazard is too severe. A few areas are irrigated by sprinkler systems. Capability unit VIe–5; Sandy range site; windbreak suitability group 3.

Doger and Dunday loamy fine sands, loamy substratum, 0 to 3 percent slopes (DfB).—These soils are on the bottoms of dry valleys and on the lower parts of the valley sides. Most areas contain both Doger and Dunday soils in proportions that range from 10 to 90 percent for each soil. Some areas, however, consist entirely of Doger soil; other areas consist entirely of Dunday soil. Most areas have a higher proportion of Doger soil than of Dunday soil. The Doger soil is at lower elevations than the Dunday soil. It has a thicker surface layer than the Dunday soil.

Both the Doger and Dunday soils in this mapping unit have a profile similar to the one described as representative for the respective series; but at a depth of 15 to 18 inches, the profile is fine sandy loam. The loamy material ranges from 10 inches to more than 60 inches thick. In many places it is stratified with layers that range from loam to sandy clay loam. The loamy material is itself underlain with light brownish-gray fine sand or loamy fine sand. In this mapping unit are some small areas where the loamy material is not present or is at depths greater than 48 inches.

Included with these soils in mapping were areas of the Elsmere soil in small depressions. Also included were a few small areas that have a slope of 3 to 5 percent.

Soil blowing is a severe hazard when the vegetative cover is removed. The water intake rate is very high. The available water capacity in this soil is moderate. Runoff is slow.

Most of the acreage of this unit is in native grass, which is used for grazing or mowed for hay. Many areas have been cultivated in the past. A few areas are used for growing alfalfa, rye, corn, and sorghum. They respond favorably to good management, particularly to applications of nitrogen. Soils in this mapping unit respond well to irrigation when a high level of management is employed. Capability unit IVe–5; Sandy range site; windbreak suitability group 3.

Dunday Series

This series consists of deep, nearly level to gently sloping, well-drained soils. Some areas have complex slopes and are gently rolling. They are mainly on the lower elevations of uplands and in dry valleys. These soils formed in wind-deposited material. In this survey area Dunday soils were mapped with Doger soils and areas of the two soils were not separated on the detailed soil map.

In a representative profile the surface layer is very friable, dark grayish-brown loamy fine sand about 14 inches thick. Beneath this is a transition layer of grayish-brown loamy fine sand about 8 inches thick. The underlying material is grayish-brown loamy fine sand to a depth of 60 inches.

The permeability of Dunday soils is generally rapid, but it is moderately rapid in the loamy substratum phase. Available water capacity is generally low, but it is moderate in the loamy substratum phase. The organic-matter content is moderately low and natural fertility is low. These soils absorb moisture easily and release it readily to plants.

Most of the acreage of Dunday soils is in native grass, which is used for grazing. Some areas are mowed for hay. These soils are marginally suited for dryland cultivated crops where the slope is not too steep. They are also suited for irrigated crops, particularly where the sprinkler system is used. Dunday soils are suited to trees and shrubs in windbreaks. They also provide nesting cover for game birds and food for the larger wildlife species.

Representative profile of Dunday loamy fine sand in an area of Doger and Dunday loamy fine sands, 0 to 3 percent slopes, in native grass, 1,850 feet east and 1,050 feet north of the southwest corner of sec. 36, T. 19 N., R. 36 W.:

A1—0 to 14 inches, dark grayish-brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; soft, very friable; many roots; neutral; gradual, smooth boundary.

AC—14 to 22 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; weak, fine, granular structure; soft, very friable; common roots; neutral; gradual, smooth boundary.

C—22 to 60 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; weak, coarse, blocky structure; soft, very friable; neutral.

The A horizon ranges from 10 to 20 inches thick, but in most places it is 14 to 20 inches thick. The solum ranges from 18 to 30 inches thick. The C horizon ranges from light gray to grayish brown in color. In most places the C horizon is loamy fine sand or fine sand in the lower part, but it is fine sandy loam in some areas.

Dunday soils are near Doger, Els, Valentine, and Elsmere soils. They have a thinner A horizon than Doger soils but a thicker A horizon than Els or Valentine soils. They are better drained than Els, Elsmere, or Gannett soils.

Els Series

This series consists of deep, nearly level and very gently sloping, somewhat poorly drained soils in wet valleys (fig. 5). The topography is low and hummocky. In most years the water table ranges from a depth of 2 or 3 feet in the spring to 5 feet early in fall. Els soils formed mainly in coarse-textured eolian material, but in places this material was reworked by moving water. Some Els soils formed where the water table rose in areas of Valentine soils.

In a representative profile a layer of about 2 inches of partly decayed organic matter overlies the soil. The surface layer of the mineral soil consists of gray fine sand 6 inches thick. Beneath this is a transition layer of gray fine sand 5 inches thick. The underlying material is light-gray, mottled fine sand to a depth of 60 inches.

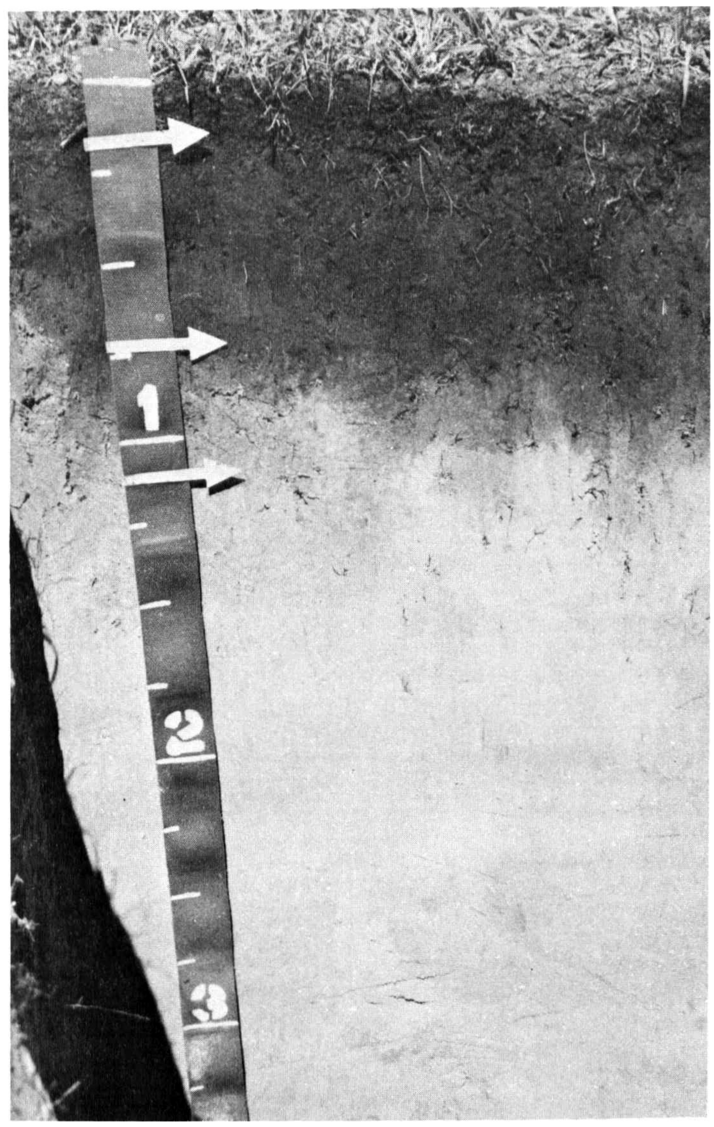


Figure 5.—**Profile of Els fine sand. This soil has a thin surface layer and a water table that ranges from a depth of 2 feet in spring to 5 feet early in fall.**

Els soils have rapid permeability and low available water capacity. Natural fertility and the content of organic matter are low. These soils absorb moisture easily and release it readily to plants. Most of the acreage of these soils is in native grass that is mowed for hay. A few areas are grazed. Many areas have been overseeded with tame grasses and legumes. Els soils are suitable for windbreaks of trees and shrubs and also provide food and cover for game birds. Deer and antelope also commonly feed in these windbreak areas. These soils are not suitable for dryland cultivated crops and are only marginally suitable for cropping under irrigation.

Representative profile of Els fine sand, 0 to 3 percent slopes, in a meadow, 1,320 feet east and 630 feet north of the center of sec. 6, T. 22 N., R. 38 W.:

O1—2 inches to 0, partly decayed organic matter; abrupt, wavy boundary.

A1—0 to 6 inches, gray (10YR 5/1) fine sand, very dark gray (10YR 3/1) moist; single grained; loose; many roots; slight effervescence; mildly alkaline; clear, wavy boundary.

AC—6 to 11 inches, gray (10YR 6/1) fine sand, dark gray (10YR 4/1) fine sand, dark gray (10YR 4/1) moist; single grained; loose; common roots; slight effervescence; mildly alkaline; gradual, wavy boundary.

C—11 to 60 inches, light-gray (2.5Y 7/2) fine sand, light brownish gray (2.5Y 6/2) moist; many, large, faint, yellowish-brown (10YR 5/4, moist) mottles; single grained; loose; few roots to depth of 24 inches; free water at a depth of 40 inches; mildly alkaline.

In places no O1 horizon is present. The A horizon ranges from 4 to 10 inches in thickness and the solum from 10 to 20 inches. The A horizon is fine sand or loamy fine sand. The color of this horizon ranges from gray to dark grayish brown. Reaction generally ranges from neutral to mildly alkaline in all parts of the profile. In the alkali phase, however, it ranges to very strongly alkaline above the water table. In some areas lime is lacking in the upper part of the profile.

Els soils are most commonly near Elsmere, Loup, Gannett, and Tryon soils. They have a thinner A horizon than Elsmere, Loup, or Gannett soils and are better drained than Loup, Gannett, or Tryon soils.

Els fine sand, 0 to 3 percent slopes (EcB).—This soil is on the bottoms of wet valleys and on the lower parts of valley sides. In a few areas the topography is low and hummocky, but in most areas it is smooth.

This soil has the profile described as representative of the series. In a few areas, however, the surface layer is darker colored and thicker than the one described in that profile. In some areas a dark buried soil is at a depth of 20 to 30 inches. The organic mulch is missing from the surface in places.

Included with this soil in mapping were small areas of Valentine soil on low ridges and hummocks. Also included, in depressions, were small areas of Loup and Tryon soils, Marsh, and lakes. In a few areas the surface layer is loamy fine sand.

In some years this soil is too wet for haying operations during the wettest seasons or following heavy rains. The high water table is generally beneficial to the native grasses. Soil blowing is a serious hazard where the vegetation has been destroyed.

This soil is well suited for use as hayland or rangeland. It is not suited to dryland cultivated crops because it is droughty during midsummer when the water table is lowest and the hazard of soil blowing is very severe. It is only marginally suitable for irrigated crops and requires a high level of management for an economically desirable return. Capability unit VIw–5; Subirrigated range site; windbreak suitability group 2.

Els loamy fine sand, alkali, 0 to 3 percent slopes (EdB).—This soil is on the bottoms of wet valleys and on the lower parts of valley sides. It is most common in the eastern parts of the wet valleys.

This soil has a profile similar to the one described as representative for the series, except that the surface layer is loamy fine sand and the soil is strongly or very strongly alkaline from a depth of 6 to 18 inches downward to the highest level of the fluctuating water table. In most places the soil lacks the layer of organic matter at the surface. In some areas the surface layer is fine sand. Locally the surface layer is as much as 14 inches thick.

Included with this soil in mapping were small areas of Loup, Marsh, and Saline-Alkali land in low areas or near wet areas. A few small areas of Doger, Dunday, and Valentine soils are on low ridges and hummocks.

Soil blowing is a very serious hazard where the surface of the soil is not protected. The alkali intensifies the effect of drought periods by reducing the size and abundance of the medium and tall grasses. The vegetation on this soil has a higher percentage of such saline- and alkali-tolerant species as alkali sacaton, bluegrass, saltgrass, and foxtail barley than the vegetation in areas of Els soils that are not so alkaline.

This soil is used as hayland or rangeland. It is not suited to cultivated crops because of the toxic effect of alkali. It is not suited to trees in windbreaks except under special conditions. It has limited use as habitat for wildlife. Capability unit VIs–1; Saline Lowland range site; windbreak suitability group 10.

Elsmere Series

This series consists of deep, nearly level and very gently sloping, somewhat poorly drained soils (fig. 6). These soils are on the bottoms of wet valleys, on the lower parts of the valley sides, and in sandhill depressions. They formed in sandy eolian material and alluvium. The depth to the water table ranges in most years from about 2 or 3 feet early in spring to 5 feet late in summer.

In a representative profile the surface layer is very friable, very dark grayish brown loamy fine sand about 18 inches thick. Beneath this is a transitional layer of light brownish-gray loamy fine sand 14 inches thick. The underlying material is pale-brown fine sand to a depth of 60 inches. It is mottled in the upper part.

Elsmere soils have rapid permeability and low available water capacity. The content of organic matter is moderate and natural fertility is low. These soils absorb moisture easily and release it readily to plants.

Elsmere soils are well suited to hay. A few areas are grazed. Many areas have been overseeded with tame grasses and legumes. Marginally suited to both dryland and irrigated crops, these soils require a high level of management to prevent soil blowing. They are suited to windbreaks of adapted trees and shrubs and provide food and nesting cover for game birds. Deer and antelope commonly feed in these areas of Elsmere soils.

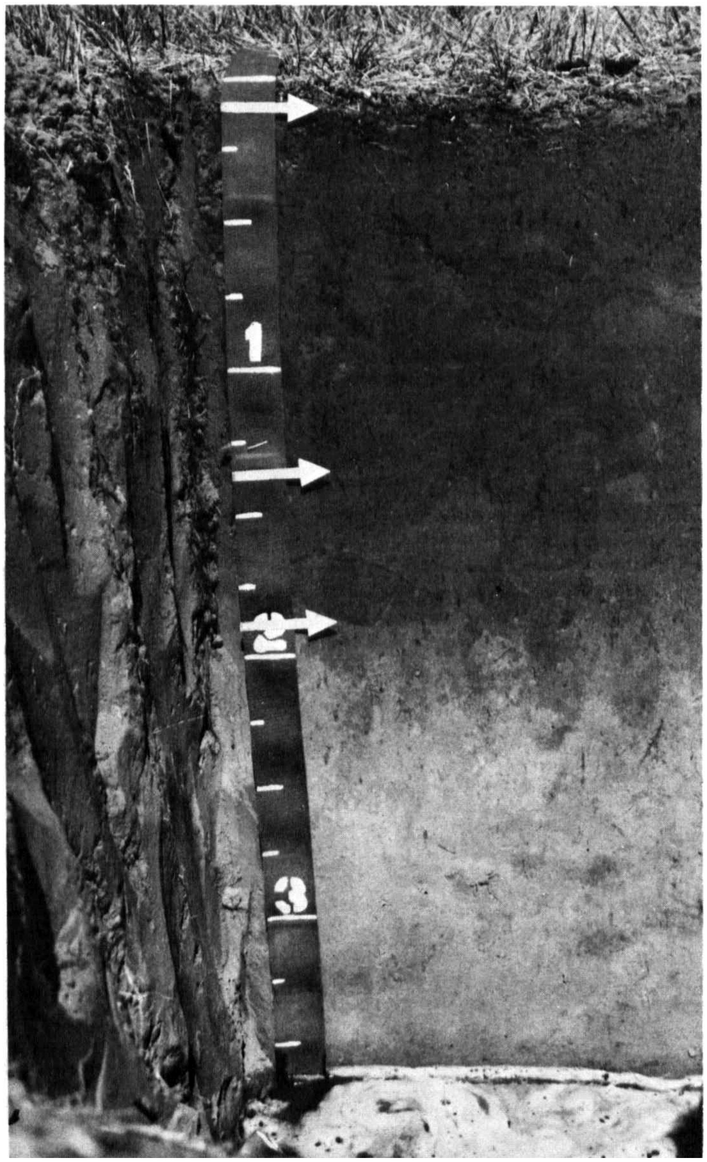


Figure 6.—**Profile of Elsmere loamy fine sand. This soil has a thick, dark-colored surface layer and a water table whose depth fluctuates from 2 to 5 feet.**

Representative profile of Elsmere loamy fine sand, 0 to 3 percent slopes, in a hay meadow, 530 feet south and 530 feet east of the center of sec. 32, T. 20 N., R. 39 W.:

A1—0 to 18 inches, very dark grayish brown (10YR 3/2) loamy fine sand, very dark brown (10YR 2/2) moist; weak, fine, granular structure; soft, very friable; many roots; slight effervescence; mildly alkaline; gradual, smooth boundary.

AC—18 to 32 inches, light brownish-gray (10YR 6/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; weak, fine, granular structure; soft, very friable; common roots; slight effervescence; free water at a depth of 28 inches; mildly alkaline; gradual, smooth boundary.

C—32 to 60 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) moist; few, large, faint mottles in upper part, yellowish brown (10YR 5/4) moist; single grained; loose, neutral.

The A horizon ranges from 10 to 20 inches in thickness and the solum from 16 to 36 inches. Mottles range from few to many, from small to large, and from faint to distinct. Reaction ranges from neutral to moderately alkaline in all parts of the soil profile. In most areas lime is in all parts of the profile above the highest level of the fluctuating water table, but in many areas the soil is noncalcareous in the A horizon.

Elsmere soils are most commonly near Els, Loup, Gannett, and Tryon soils. Less commonly they are associated with Doger and Dunday soils. Elsmere soils have a higher water table than Doger and Dunday soils and consequently are not as well drained. They have a thicker A horizon than Els soils, and they are better drained than Loup, Gannett, or Tryon soils.

Elsmere loamy fine sand, 0 to 3 percent slopes (EfB).—This soil is on the bottoms of wet valleys, on the lower parts of valley sides, and in low areas of the sandhills where the water table is at a depth of 2 to 5 feet.

In this mapping unit are small areas where the surface layer is 20 to 40 inches thick. In other areas some thin layers of fine sandy loam are in the underlying material. In low areas there is a thin layer of organic matter on the surface.

Included with this soil in mapping were small areas of Doger, Dunday, and Valentine soils on low ridges and low hummocks. Also included were small areas of Loup and Gannett soils, Marsh, and lakes in depressions and at slightly lower elevations. Other inclusions were small areas of Els loamy fine sand, alkali, and areas of Saline-Alkali land.

Early in spring, when the water table is highest, this soil is too wet for timely tillage operations. These operations are commonly delayed for several weeks. This soil warms up slower in the spring than better drained soils. The high water table, however, is generally beneficial to native grasses. Soil blowing is a hazard where a vegetative cover has not been maintained.

This soil is used mainly as hayland. A small part is grazed. It is suited to cultivated crops, both dryland and irrigated, but is only marginally suited to this use. Capability unit IVw–5; Subirrigated range site; windbreak suitability group 2.

Gannett Series

This series consists of deep, nearly level, poorly and very poorly drained soils (fig. 7). They are on the bottoms of wet valleys, on the lower parts of valley sides, and in depressions. These soils formed in loamy and sandy materials that were windblown or stream-deposited. Some soil areas formed when areas of Marsh or lakes were drained. The water table ranges from above the surface early in spring (some years) to a depth of 3 feet in summer.

In a representative profile about 1 inch of partly decayed organic matter is on the surface. The upper part of the mineral surface layer consists of 9 inches of friable, very dark gray fine sandy loam and 5 inches of very dark gray silt loam. The lower part is 9 inches of gray and dark-gray loamy fine sand and fine sandy loam. Beneath this is a transition layer of gray fine sand, 4 inches thick. The underlying material is gray fine sand to a depth of 60 inches.

Gannett soils have moderately rapid permeability in the upper part. Permeability is rapid in the fine sand of the underlying material. The available water capacity is moderate, and the organic-matter content is

Figure 7.—**Profile of a Gannett soil. This soil has a thick surface layer and a high water table.**

moderate. Natural fertility is medium. These soils absorb moisture easily and release it readily to plants.

Gannett soils are too wet for the commonly cultivated crops. They are, however, well suited to grass. Many areas, having been overseeded with tame grasses and legumes, are mowed for hay. These areas commonly provide food and cover for wildlife. Only trees and shrubs that can withstand a wet soil condition are suitable for use as windbreaks in Gannett soils.

In this survey area Gannett soils were mapped only in complexes with Loup soils.

Representative profile of Gannett fine sandy loam in an area of Gannett-Loup fine sandy loams, 0 to 2 percent slopes, in a meadow, 1,320 feet north of the southwest corner of sec. 26, T. 24 N., R. 38 W.:

O1—1 inch to 0, partly decayed organic matter; abrupt, smooth boundary.

A11—0 to 9 inches, very dark gray (10YR 3/1) fine sandy loam, black (10YR 2/1) moist; weak, fine, granular structure; slightly hard, friable; many roots; moderately alkaline; gradual, wavy boundary.

A12—9 to 14 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) moist; weak, medium, subangular blocky structure; hard, friable; many roots; mildly alkaline; abrupt, wavy boundary.

A13—14 to 16 inches, gray (10YR 5/1) loamy fine sand, very dark gray (10YR 3/1) moist; single grained; soft, friable; few roots; mildly alkaline; abrupt, wavy boundary.

A14—16 to 23 inches, dark-gray (2.5Y 4/0) fine sandy loam, very dark gray (2.5Y 3/1) moist; weak, medium, granular structure; slightly hard, friable; few roots; mildly alkaline; gradual, wavy boundary.

AC—23 to 29 inches, gray (2.5Y 5/0) fine sand, very dark gray (5Y 3/1) moist; single grained; loose; mildly alkaline; gradual, wavy boundary.

C—29 to 60 inches, light-gray (2.5Y 7/0) fine sand, dark gray (5Y 4/1) moist; single grained; loose; mildly alkaline.

The O1 horizon ranges from 0 to 4 inches in thickness and the solum from 13 to 27 inches. In places the AC and C horizons are mottled. The A horizon is dominantly fine sandy loam or loamy fine sand, but in places it contains layers of silt loam, loam, or fine sand. These soils are mainly noncalcareous throughout the profile, but in many areas they are calcareous in the upper part of the A horizon.

Gannett soils are most commonly near Els, Elsmere, and Loup soils. Less commonly they are near Doger and Dunday soils. Gannett soils have a finer textured A horizon than Els and Elsmere soils, and they have a thicker and finer textured A horizon than Loup soils. They are more poorly drained than Doger, Dunday, Els, and Elsmere soils.

Gannett-Loup fine sandy loams, 0 to 2 percent slopes (Ga).—These soils are on the bottoms of wet valleys and in depressions. This mapping unit is a complex of two soils, Gannett fine sandy loam and Loup fine sandy loam. The Gannett soil occupies 45 to 75 percent of each delineation and the Loup soil occupies 20 to 50 percent. Other included soils occupy 5 to 10 percent. In most places the Gannett soil is slightly lower in elevation than the Loup soil. In most years the water table is commonly above the surface early in spring. It recedes to a depth of about 2 feet early in fall.

The Gannett soil in this unit has the profile described as representative for the series. The Loup soil has a profile similar to the one described for the Loup series, but the surface layer is fine sandy loam. In many places the surface layer of these soils is as much as 42 inches thick.

Included with this soil in mapping were small areas of Elsmere soils at higher elevations. Also included were small areas of the drained phases of the Gannett and Loup soils at slightly higher elevations.

Wetness from the high water table is the characteristic that most limits the use of these soils. During the wettest seasons they are commonly too wet for haying operations. Runoff is very slow, or the surface is ponded.

These soils are used mainly as hayland. Some small areas are grazed. The soils are too wet for the commonly cultivated crops. Capability unit Vw-7; Wet Land range site; windbreak suitability group 6.

Gannett-Loup fine sandy loams, drained, 0 to 2 percent slopes (Gb).—These soils occur on the bottoms of wet valleys, on the lower parts of valley sides, and in depressions. The water table fluctuates from a depth of about 1 or 2 feet early in spring to 3 feet by early fall.

The relative elevation of these soils is not quite as low and the water table is not quite as high as those in Gannett-Loup fine sandy loams, 0 to 2 percent slopes. Consequently, the grasses that grow are commonly of the bunch type.

This mapping unit is a complex of Gannett fine sandy loam and Loup fine sandy loam. These soils occur together. The Gannett soil is generally a bit lower in elevation than the Loup soil. In this mapping unit the Gannett soil occupies 50 to 70 percent of the individual areas and the Loup soil occupies 30 to 50 percent.

The Gannett soil in this complex has a profile similar to the one described as representative of the series. The Loup soil in this complex has a profile similar to the one described as representative for the Loup series, but the surface layer is fine sandy loam. The soils in some areas have a surface layer as thick as 42 inches. In places the water table is above the surface early in spring.

Included with these soils in mapping were small areas of Marsh and lakes in lower elevations. Small areas of Elsmere soils on slightly higher elevations were also included.

The high water table of these soils influences their use. Areas of this mapping unit are used mainly as hayland. A few are grazed. They are too wet for the commonly cultivated crops. Capability unit Vw–7; Subirrigated range site; windbreak suitability group 6.

Loup Series

This series consists of deep, nearly level, poorly and very poorly drained soils (fig. 8) on the bottoms of wet valleys, on the lower part of valley sides, and in depressions of the sandhills. They formed in eolian and alluvial materials. Soils of the Loup series have a water table that is above the surface in the wettest seasons, ranging to a depth of about 3 feet early in fall.

In a representative profile there is about 1 inch of partly decayed organic matter on the surface. The surface layer of the mineral soil is about 11 inches thick. The upper part is gray, very friable loamy fine sand; the middle part is gray fine sandy loam; and the lower part is grayish-brown loamy fine sand. The underlying material is light-gray fine sand in the upper part, grayish-brown loamy fine sand in the middle part, and light-gray fine sand in the lower part.

Loup soils have rapid permeability and low available water capacity. The organic-matter content is moderate, and natural fertility is medium. They absorb moisture easily and release it readily to plants.

Loup soils are suited to grass and most areas are mowed for hay. They are too wet for the commonly cultivated crops. For windbreaks they are suited to trees and shrubs that can withstand the soil wetness. They are also suitable for wildlife habitat.

In this survey Loup soils were mapped only in complexes with Gannett soils.

Representative profile of Loup loamy fine sand in an area of Loup-Gannett loamy fine sands, 0 to 2 percent slopes, in a meadow, 1,584 feet west of the center of sec. 22, T. 24 N., R. 36 W.:

O1—1 inch to 0, partly decayed organic matter; abrupt, smooth boundary.

A11—0 to 5 inches, gray (10YR 5/1) loamy fine sand, very dark brown (10YR 2/2) moist; weak, fine, granular structure; soft, very friable; many roots; violent effervescence; mildly alkaline; clear, wavy boundary.

A12—5 to 9 inches, gray (10YR 5/1) fine sandy loam, black (10YR 2/1) moist; weak, fine, granular structure; slightly hard, friable; many roots; violent effervescence; mildly alkaline; clear, wavy boundary.

A13—9 to 11 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; soft, very friable; many roots; mildly alkaline; clear, wavy boundary.

C1—11 to 32 inches, light-gray (10YR 7/2) fine sand, light brownish gray (10YR 6/2) moist; many, large, faint mottles yellowish brown (10YR 5/4) moist; single grained; loose; few roots to 20 inches; mildly alkaline; abrupt, wavy boundary.

Ab—32 to 39 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark gray (10YR 3/1) moist; single grained; soft, loose; mildly alkaline; clear, wavy boundary.

C2—39 to 60 inches, light-gray (10YR 7/1) fine sand, gray (10YR 6/1) moist; single grained; loose; mildly alkaline.

The O1 horizon ranges from 0 to 4 inches in thickness. The A horizon ranges from 10 to 16 inches thick and is

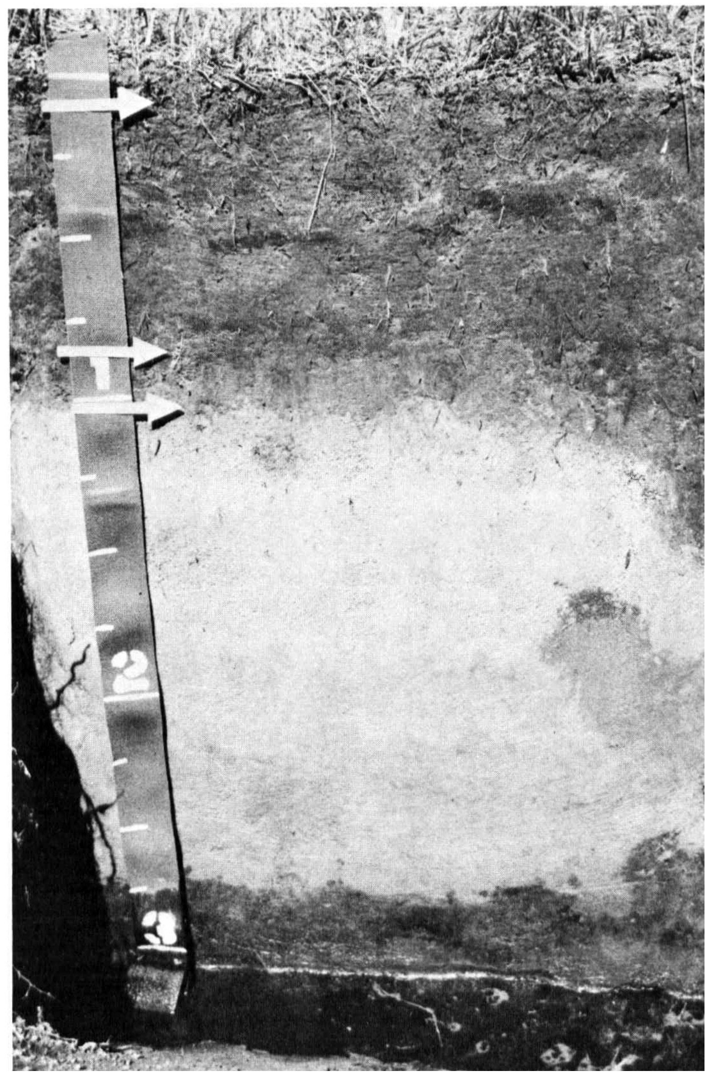


Figure 8.—**Profile of Loup loamy fine sand. This sandy soil has a high water table.**

dominantly loamy fine sand and fine sandy loam. It ranges from neutral to moderately alkaline in reaction. The solum ranges from 10 to 20 inches in thickness. Buried soils are present in many places. Lime is commonly present in the upper few inches of the soil, but many areas are noncalcareous. The C horizon is mildly alkaline or moderately alkaline in reaction.

In the landscape Loup soils are most commonly near Els, Elsmere, Gannett, and Tryon soils. Less commonly they are associated with Doger and Dunday soils. They are not as well drained as Doger or Dunday soils. They are more poorly drained than Els or Elsmere soils. They have a thicker A horizon than Tryon soils, but a thinner and coarser textured A horizon than Gannett soils.

Loup-Gannett loamy fine sands, 0 to 2 percent slopes (Ld).—This soil occurs mainly in wet valleys and small depressions. In most years the water table is above the surface of the soil early in spring, but recedes to a depth of about 2 feet early in fall.

This mapping unit consists of two soils. Loup loamy fine sand occupies about 50 to 80 percent of the unit and Gannett loamy fine sand occupies the other 20 to 50 percent. Generally, their pattern of occurrence within an area is not well defined, but the Gannett soil is commonly lower than the Loup soil.

The Loup soil in this complex has the profile described as representative for the Loup series. The Gannett soil has a profile similar to the one described for the Gannett series, but the surface layer is loamy fine sand.

Included with these soils in mapping were a few areas in which the surface layer is only 6 to 10 inches thick and a few areas in which it is 20 to 30 inches thick. In a few places the surface layer is fine sand; in a few other places it is fine sandy loam. Also included were a few areas of Marsh and lakes.

Wetness from the water table limits the use of these soils. The areas are commonly too wet for haying operations during wet seasons or after heavy rains. Runoff is ponded or very slow. Bunch grasses are not common in these areas.

The soils in this mapping unit are used mainly as hayland. They are too wet for cultivated crops. A few areas are grazed. Capability unit Vw–7; Wet Land range site; windbreak suitability group 6.

Loup-Gannett loamy fine sands, drained, 0 to 2 percent slopes. (Lf).—Soils in this complex are on the bottoms of wet valleys, on the lower parts of valley sides, and in depressions. In most years the water table is at a depth of 1 to 2 feet early in spring. It recedes to a depth of 3 feet early in fall. It is not quite as high as that of the Loup-Gannett loamy fine sands, 0 to 2 percent slopes. Areas of the mapping unit are composed of two principal soils. Loup loamy fine sand occupies 50 to 80 percent of the areas and Gannett loamy fine sand occupies the other 20 to 50 percent. The pattern of their occurrence is not well defined, but the Gannett soil is generally lower in the landscape than the Loup soil.

The Loup soil has a profile similar to the one described for the Loup series. The Gannett soil has a profile similar to the one described for the Gannett soil, but the surface layer is loamy fine sand. In this mapping unit are a few small areas in which the surface layer is 20 to 30 inches thick. In a few places the surface layer is fine sand; in a few other places it is fine sandy loam.

Included with these soils in mapping were small areas of Marsh and lakes in lower elevations. Also included were small areas of Els and Elsmere soils on slightly higher elevations. In places the water table is above the surface in spring or after heavy rains.

Soil wetness is the hazard that most limits the use of this soil. During some seasons the areas are too wet for timely haying operations. Runoff is very slow, or the surface is ponded. Bunch grasses are common in these areas.

Areas in this complex are used mainly as hayland. A few areas are grazed. These soils are not suited to cultivated crops because of the wetness. Capability unit Vw–7; Subirrigated range site; windbreak suitability group 6.

Marsh

Marsh (0 to 1 percent slopes) (Ma) is along shores of lakes, in the bottoms of valleys, and in some low areas of the sandhills. Typically, Marsh areas have a water table above the surface in spring and early in summer; it commonly recedes to a depth of 1 or 2 feet below the surface late in summer and early in fall.

Soil material in Marsh ranges from fine sandy loam to fine sand. In some areas the material is all one texture, but in other areas it is variously stratified with loamy and sandy material.

Included with Marsh in mapping were small areas of Gannett, Loup, and Tryon soils, all at slightly higher elevations. Also included were small lakes in low areas.

Nearly all the acreage of Marsh is in native vegetation, mainly cattails, rushes, arrowheads, and burreed. Open water is present in a small part of some areas.

Marsh is better suited to habitat for wetland wildlife than it is to other uses. The areas are too wet for grazing or mowing, and the vegetation is coarse and nonpalatable for livestock. Capability unit VIIIw–7; windbreak suitability group 10; no range site assigned.

Saline-Alkali Land

Saline-Alkali land (0 to 2 percent slopes) (Sa) is poorly drained. It occurs in enclosed valleys and depressions. The soil material is strongly or very strongly alkaline in the upper 12 inches of the horizon. In most years the water table fluctuates from a depth of 1 or 2 feet early in spring to 3 feet early in fall.

Many kinds of soil material are included in this mapping unit. The degree of development is weak in most places. In some places, however, there is a developed subsoil. The surface layer is 2 to 10 inches of fine sandy loam, loamy fine sand, or fine sand. Its color ranges from gray to dark grayish brown. In places there is a light gray, platy subsurface layer that is underlain by a well developed, sandy clay loam subsoil that has blocky structure. The underlying material, at a depth of 10 to 30 inches, is mainly single-grained, mottled fine sand. Whitish, grayish, or brownish accumulations of salt are common on the surface, particularly during summer and early in fall.

Included with this mapping unit were small areas of Tryon, Loup, and Gannett soils. In places areas of Marsh at slightly lower elevations were included. Also included, at slightly higher elevations, were small areas of the alkali phase of Els loamy fine sand.

Permeability of the soil material ranges from moderate to rapid. The available water capacity is low because the alkalinity tends to hold moisture and release it slowly to plants. The content of organic matter is low. Natural fertility is low, and available plant nutrients are poorly balanced because of the effect of soil reaction.

The main limitation of Saline-Alkali land is its strong alkalinity and salinity. These properties influence the quality and quantity of grass. Also important is the high water table that subirrigates the soil material and keeps it moist during much of the year.

Nearly all areas of this unit are in native grass and are mowed for hay. A few areas are grazed. This mapping unit is not suited to commonly cultivated crops. The native vegetation is dominantly alkali-tolerant grasses such as saltgrass, alkali cordgrass, western wheatgrass, foxtail barley, and bluegrass. Vegetation is sparse where the soil material is very severely affected by alkalinity. Capability unit VIs–1; Saline Subirrigated range site; windbreak suitability group 10.

Tryon Series

This series consists of deep, nearly level, poorly drained and very poorly drained soils (fig. 9). They are on the bottoms of wet valleys, on the lower parts of valley sides, and in depressions of the sandhills. In most years the water table fluctuates from a depth of 1 foot above the surface in spring to a depth of 3 feet early in fall. These soils formed in sandy eolian and alluvial materials. A few areas were formed where the water table in Marsh and lake areas was artificially lowered.

In a representative profile there is about 1 inch of partly decayed organic matter at the surface. The surface layer of the mineral soil is very friable, dark-gray loamy fine sand about 5 inches thick. Beneath this is a transition layer that consists of grayish-brown fine sand, 3 inches thick. The underlying material of fine sand, to a depth of 60 inches, is light brownish-gray and mottled in the upper part and pale brown in the lower part.

Tryon soils have rapid permeability and low available water capacity. The organic-matter content is moderately low and natural fertility is low. These soils absorb moisture easily and release it readily to plants.

Tryon soils are best suited for grass. Most of the grass is mowed for hay but some is grazed. Wildlife use the areas for food and cover. Tryon soils are suited to those trees and shrubs that can tolerate the high water table. These soils are too wet for the commonly cultivated crops.

Representative profile of Tryon loamy fine sand, 0 to 2 percent slopes, in a meadow, 1,320 feet east and 790 feet south of the northwest corner of sec. 6, T. 23 N., R. 40 W.:

O1—1 inch to 0, partly decayed organic matter; abrupt, smooth boundary.

A1—0 to 5 inches, dark-gray (10YR 4/1) loamy fine sand, black (10YR 2/1) moist; weak, fine, granular structure; soft, very friable; many roots; mildly alkaline; clear, wavy boundary.

AC—5 to 8 inches, grayish-brown (10YR 5/2) fine sand, dark grayish brown (10YR 4/2) moist; many, fine and medium, distinct mottles, yellowish brown (10YR 5/4) moist mostly along root channels; single grained; loose; many roots; neutral; diffuse, wavy boundary.

C1—8 to 12 inches, light brownish-gray (10YR 6/2) fine sand, grayish brown (10YR 5/2) moist; fine and medium, distinct mottles, yellowish brown (10YR 5/4) moist, mostly along root channels; single grained; loose; common roots; neutral; diffuse, wavy boundary.

C2—12 to 60 inches, pale-brown (10YR 6/3) fine sand; grayish brown (10YR 5/2) moist; single grained; loose, neutral.

The O horizon ranges from 0 to 4 inches in thickness. The A horizon ranges from 3 to 10 inches in thickness. The latter is dominantly loamy fine sand, but is fine sand in a few small areas. The AC horizon is not present in many areas. Buried soils are in many areas at a depth of 24 to 40 inches. Faint to distinct mottles are in the C horizon in some areas. The AC and C horizons range from neutral to mildly alkaline in reaction.

In the landscape Tryon soils are most commonly near Els, Elsmere, and Loup soils. They are more poorly drained

Figure 9.—**Profile of Tryon loamy fine sand. This soil has a thin surface layer and a water table at a depth of 2½ feet.**

than Els or Elsmere soils. They have a thinner A horizon than Elsmere soils. Tryon soils have a thinner A horizon than Loup soils and are coarser textured in most parts of the A horizon than Gannett soils.

Tryon loamy fine sand, 0 to 2 percent slopes (Tk).—This soil is on the bottoms of wet valleys and in depressions of the sandhills. In most years the water table ranges from about 1 foot above the surface early in spring to a depth of 1 foot below it early in fall.

This soil has the profile described as representative for the series. In a few places the surface layer is fine sandy loam, and in a few other places it is fine sand.

Included with this soil in mapping were small areas of Els soils at the higher elevations and small areas of Marsh and lakes in depressions. Also included were some areas of the drained phase of Loup loamy fine sand, which has a lower water table.

Wetness is the principal hazard that limits the use of the soil. It is commonly too wet for timely haying operations during wet seasons and following heavy rains.

This soil is used mainly as hayland. A few areas are grazed. It is not suited to the commonly cultivated crops because the water table is too high. Bunch grasses are not common in areas of this soil. Capability unit Vw–7; Wet Land range site; windbreak suitability group 6.

Tryon loamy fine sand, drained, 0 to 2 percent slopes (Tn).—This soil is on the bottoms of wet valleys, on the concave lower parts of valley sides, and in depressions of the sandhills. In most years the water table ranges from a depth of 1 to 2 feet early in spring to a depth of about 2 feet early in fall. This is slightly lower than that found in areas of Tryon loamy fine sand, 0 to 2 percent slopes.

This soil has a profile similar to the one described as representative for the series, but the water table is not as high. Included with this soil in mapping were a few areas where the surface layer is fine sandy loam, a few areas where the surface layer is fine sand, small areas of Els soils on slightly higher elevations, small areas of Marsh and lakes, and small areas of the typical Loup soil that has a higher water table.

During wet seasons the soil is too wet for timely haying operations. Wetness is the principal hazard that limits the use of the soil. Runoff is ponded or very slow. Bunch grasses are common in areas of this soil.

This soil is used mainly as hayland. A few areas are grazed. It is not suited to the commonly cultivated crops because it is too wet. Wildlife use the areas for food and cover. Capability unit Vw–7; Subirrigated range site; windbreak suitability group 6.

Valentine Series

This series consists of deep, nearly level to hilly, excessively drained soils. They occur on choppy dunes and rolling hills of the uplands as well as in dry valleys. They formed in coarse-textured, wind-deposited material.

In a representative profile (fig. 10) the surface layer is grayish-brown, loose fine sand about 8 inches thick. Beneath this is a transitional layer of grayish-brown fine sand about 10 inches thick. The underlying material is light brownish-gray fine sand to a depth of 60 inches.

Valentine soils have rapid permeability and low available water capacity. The organic-matter content and natural fertility are low. These soils absorb moisture easily and release it readily to plants.

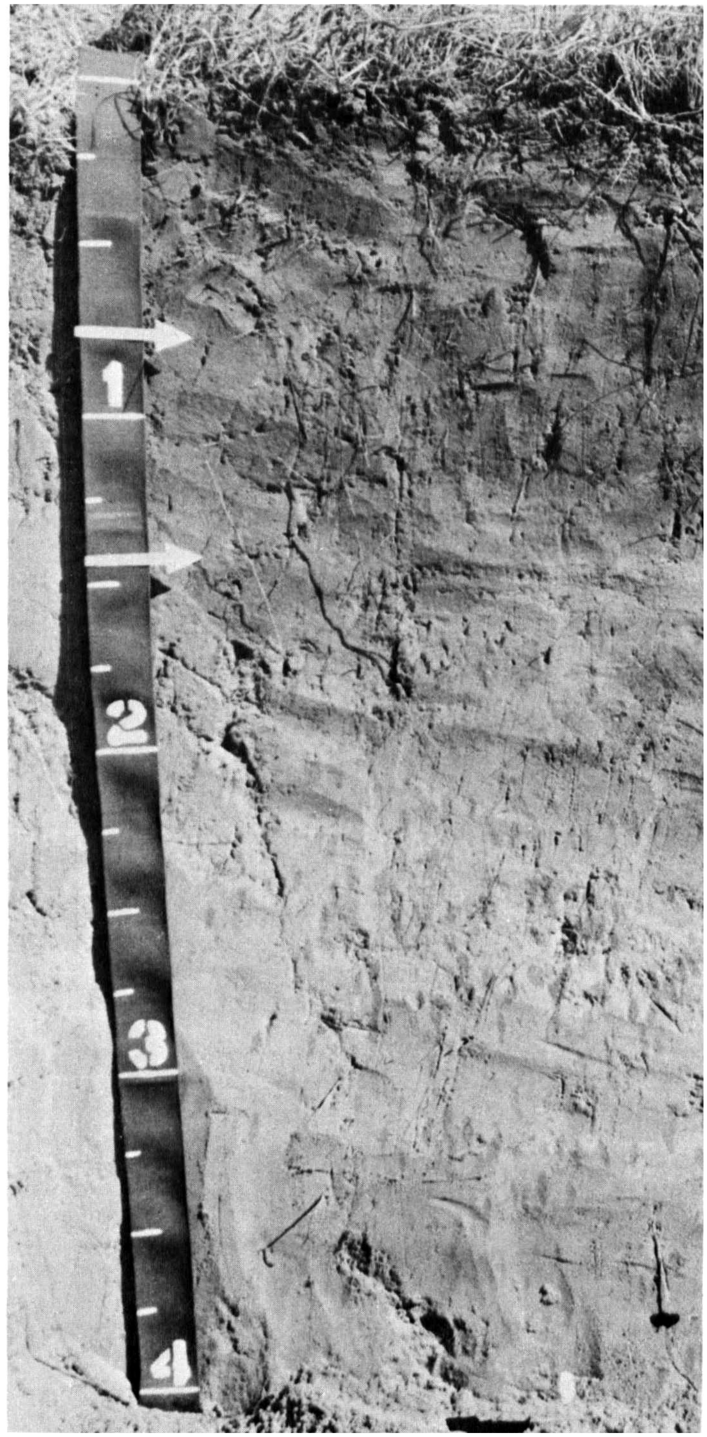


Figure 10.—Profile of Valentine fine sand. This coarse-textured soil is the most common soil in the Sandhills area of Nebraska.

Valentine soils are well suited to grass and are used mainly for rangeland. They are also suited to wildlife habitat. Where the slope is not too steep, Valentine soils are suited to trees and shrubs in windbreaks. They are too droughty for cultivated crops under dryland management, but they can be irrigated successfully if the slope is not too steep and if a high level of management is used. The choice of crops under irrigation is also extremely limited.

Representative profile of Valentine fine sand, rolling, in native grass, 790 feet south of the northeast corner of sec. 22, T. 18 N., R. 36 W.:

A1—0 to 8 inches, grayish-brown (10YR 5/2) fine sand, very dark grayish brown (10YR 3/2) moist; single grained; loose; many roots; neutral; gradual; smooth boundary.

AC—8 to 18 inches, grayish-brown (10YR 5/2) fine sand, dark grayish brown (10YR 4/2) moist; single grained; loose; common roots; neutral; gradual, smooth boundary.

C—18 to 60 inches, light brownish-gray (10YR 6/2) fine sand, grayish brown (10YR 5/2) moist; single grained; loose; few roots; neutral.

The A horizon ranges from 2 to 10 inches thick. Most areas are dominantly fine sand in the A horizon, but some small areas are loamy fine sand. The solum ranges from 5 to 17 inches thick. Buried soils that are fine sand or loamy fine sand and 3 to 10 inches thick are commonly present from a depth of 36 to 60 inches.

In the landscape Valentine soils are most commonly near Doger and Dunday soils. Less commonly they are near Elsmere, Gannett, and Loup soils. They have a thinner A horizon and are coarser textured than Doger and Dunday soils. They do not have the moderately high water table of Elsmere soils or the high water table of Gannett and Loup soils. In addition, Valentine soils have a thinner A horizon than Elsmere or Loup soils.

Valentine fine sand, 0 to 3 percent slopes (VaB).—This soil occurs on the higher parts of dry valleys and on the lower parts of valley sides. The water table is below a depth of 5 feet.

This soil has a profile similar to the one described as representative for the series, but the surface layer is slightly thicker. Mapped with this soil were a few areas where the surface layer is loamy fine sand.

Included with this soil in mapping were small areas of Doger, Dunday, Els, and Elsmere soils on slightly lower elevations. Also included were a few small areas of Gannett, Loup, and Tryon soils in shallow depressions. Small areas of Marsh and lakes are in some of the lowest areas. Also included were a few small areas of Valentine fine sand, rolling, and a few blowouts.

Soil blowing is a serious hazard when the surface is not protected. This mapping unit is a droughty soil when used for cultivated crops. Runoff is slow. Nitrogen and phosphorus are generally low.

This soil is used primarily as rangeland. A small acreage is usually mowed for hay. A few areas are used for irrigated cropland. Irrigation can be successful, but the low available water capacity and the danger of soil blowing require a high level of management. The risk of damage by soil blowing and the droughty nature of the soil make this soil unsuited to cultivated crops under dryland management. Capability unit VIe–5; Sandy range site; windbreak suitability group 7.

Valentine fine sand, rolling (3 to 17 percent slopes) (VaE).—This soil is on smooth and rounded hills of the uplands where the slopes are complex. The areas are generally large, ranging from 80 acres to several thousand acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping were areas of Valentine fine sand, hilly, that range up to 80 acres in size and many small areas of nearly level Valentine fine sand in low swales and in enclosed small valleys. Also included were Doger and Dunday soils in a few small dry valleys; small areas of Els, Elsmere, Gannett, Loup, and Tryon soils; and areas of Marsh and lakes in depressions.

Runoff is slow. Soil blowing is a very serious hazard where the soil is not protected. Droughtiness is a hazard during seasons of low rainfall. Nitrogen and phosphorus are low.

This soil is used primarily for rangeland. A few areas are mowed for hay. Where areas of sufficient size are available and the slope does not exceed 6 percent, this soil can be used for irrigated cultivated crops, provided a high level of management is employed. Under cultivation, soil blowing and the droughty nature of the soil are the main hazards. The sprinkler system is the only practical method of water application used with this soil. Capability unit VIe–5; Sands range site; windbreak suitability group 7.

Valentine fine sand, rolling and hilly (9 to 60 percent slopes) (VaF).—This mapping unit includes large areas where rolling and hilly landscapes are closely intermingled (fig. 11). Irregular catsteps are common on side slopes of the hilly part. Vegetation is commonly sparser on the hilly part than on the rolling part. Two soils—Valentine fine sand, rolling, and Valentine fine sand, hilly—each occupy 30 to 70 percent of the mapping unit. The hilly part is commonly higher in elevation than the rolling part. Areas of this unit are large, ranging in size from 80 acres to more than several thousand acres.

The rolling landscape has a profile similar to the one described as representative of the Valentine series. The hilly landscape has a similar profile, but the surface layer is thinner and lighter colored. Included with these soils in mapping were a few blowouts. Blowouts over 2 acres in size are shown on the detailed soil map by a special spot symbol.

Runoff is slow to medium depending on the slope and the amount of vegetative cover on the surface.

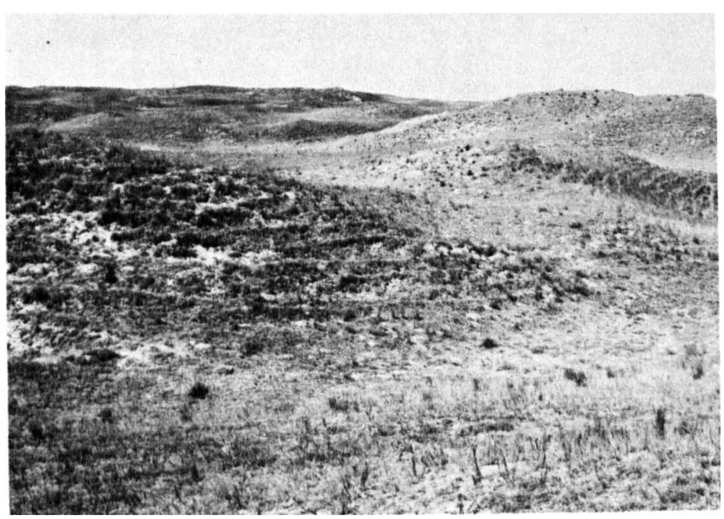


Figure 11.—**Landscape of Valentine fine sand, rolling and hilly. The hilly part has catsteps on the side slopes.**

Soil blowing is a very serious hazard when the surface layer is not protected. This is a particular hazard on the hilly part. Droughtiness is a hazard during extended periods of low rainfall.

The mapping unit is used almost entirely as rangeland. It is not suited to the commonly cultivated crops. Also, the hilly part is not suited to the planting of trees or shrubs in windbreaks. Capability unit VIIe-5; the rolling part is in the Sands range site, and the hilly part is in the Choppy Sands range site; the rolling part is in windbreak suitability group 7, and the hilly part is in windbreak suitability group 10.

Valentine fine sand, hilly (17 to 60 percent slopes) (VaG).—This soil is on the highest and steepest dunes and hills of the uplands. Many of the dunes occur as elongated ridges, but many are pointed at the top. Most of the very steep areas have irregular catsteps on the side slopes.

This soil has a profile similar to that described as representative of the series, but the surface layer is thinner, generally less than 4 inches thick and also slightly lighter colored. The transition horizon is also thinner or is not present.

Included with this soil in mapping were areas of Valentine fine sand, rolling, that are up to 80 acres in size. These are on the lower and smoother parts of the landscape. Also included were a few blowouts commonly on side slopes or on crests of the dunes. The blowouts over 2 acres in size are shown on the detailed soil map by a special spot symbol.

Runoff is slow to medium depending on the steepness of slope and the amount of vegetative cover. Soil blowing is a very serious hazard because many small areas are not well vegetated and are thus exposed to the wind.

This soil is used as rangeland. It is not suited to the commonly cultivated crops or to plantings of trees or shrubs because of the combination of steep and very steep slopes and coarse soil texture. Capability unit VIIe-5; Choppy Sands range site; windbreak suitability group 10.

Use and Management of the Soils

This section provides information on the use and capabilities of the soils in Arthur and Grant Counties for dryland and irrigated crops. This is followed by information about the range sites of the different soils in the two counties, some management and improvement practices, and the production that can be expected during favorable and unfavorable years for a site in excellent condition. Information on the suitability of the soils for growing trees and shrubs, particularly in windbreaks, is then followed by a discussion of the capacity of each soil association to produce food and cover for wildlife. The section concludes with a presentation of various engineering estimates, interpretations, and test data for the soils and a discussion of how these affect the use of the soils for engineering purposes.

Use of the Soils for Crops [2]

Only 2 percent of the soils of Arthur and Grant Counties are used for crops. The principal cropland soils occur in valleys and lowlands, which are protected from the wind and the hazard of soil blowing. The soils most suitable for cropland use are the Doger, Dunday, and Elsmere loamy fine sands.

Managing dryfarmed cropland

The valley and lowland soils of Arthur and Grant Counties are the most suitable for crop production. When cultivated, the soils of the sandhills are too exposed to the wind to withstand the very severe hazard of soil blowing. The present cover of natural grass is adequate in nearly all areas to prevent soil blowing. It will remain adequate, however, only if a good year-round cover is maintained.

The Doger, Dunday, and Elsmere loamy fine sands are soils suitable for corn, rye, sorghum, and alfalfa. Where the soil is tilled, the surface needs to be protected by a cover of crop residues or mulches. Till planting equipment or the use of lister planters, both operating without previous soil tillage, is usually adequate to prevent soil blowing when planting row crops. These methods use crop residue as mulch or ridging of the surface to reduce soil blowing. Crop residues need to be protected from heavy fall and winter grazing in order to avoid reducing the total amount of cover on the surface. Adjusting the planting dates to early summer, when the wind velocities are lowest, will help to establish alfalfa stands without a serious blowing problem.

Soil blowing can be reduced on the cultivated soils by stripcropping, which is growing narrow strips of alternate close-sown crops and row crops. In general, a row crop should not follow a row crop in the cropping sequence. A mixture of rye and vetch, planted between the existing corn rows in early fall, can provide a harvestable crop the following season and will help to prevent soil blowing.

Managing irrigated cropland

Alfalfa is the main irrigated crop in Arthur and Grant Counties. Some bromegrass is commonly mixed with the alfalfa, and the hay is used for wintering livestock. Fertilizer for the alfalfa crop needs to be applied in amounts indicated by soil tests. Phosphorus and occasionally sulfur are needed to maintain good production.

The sprinkler irrigation system is the only type adapted for irrigating these soils. High rates of infiltration on nearly all soils make it impossible to distribute the irrigation water evenly with other systems. The available water capacity ranges from low to moderate. This means that the application of irrigation water should be light and frequent. Irrigation water is supplied almost entirely from shallow or deep wells.

The capability of the soils for irrigated crops and the limitations and hazards involved should be carefully reviewed before the purchase and installation of an irrigation system.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of fields crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are

[2] By E. O. PETERSON, conservation agronomist, Soil Conservation Service.

so used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops or to other crops that require special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitation of groups of soils for range, for forest trees, or for engineering.

In the capability system, the kinds of soils are grouped at three levels: capability class, subclass, and unit.

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

Class I soils have few limitations that restrict their use.
(None in Arthur and Grant Counties.)

Class II soils have moderate limitations that reduce the choice of plants or require moderate conservation practices.
(None in Arthur and Grant Counties.)

Class III soils have severe limitations that reduce the choice of plants or require special conservation practices, or both.
(None in Arthur and Grant Counties.)

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife.

Class VI soils have severe limitations that make them generally unsuitable for cultivation and limit their use largely to pasture, range, woodland, or wildlife.

Class VII soils have very severe limitations that make them unsuitable for cultivation and restrict their use largely to pasture, range, woodland, or wildlife.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife, water supply, or to esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IVe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States but not in Arthur and Grant Counties, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops or pasture plants, to require similar management, and to have similar productivity and other responses to management. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, Vw-7 or VIe-5. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass or kind of limitation as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

The capability unit designation for each soil in the two counties can be found in the "Guide to Mapping Units." In the following pages the capability units in Arthur and Grant Counties are described, and suggestions for the use and management of the soils are given.

CAPABILITY UNIT IVe-5

This unit consists of deep, nearly level and very gently sloping, well-drained soils that have a surface layer of loamy fine sand. The underlying material is also loamy fine sand, except in a few places where it is fine sandy loam. These soils are on the bottoms and lower sides of dry valleys.

The soils in this mapping unit have rapid or moderately rapid permeability and low or moderate available water capacity. Water intake is rapid and runoff is slow. Content of organic matter is moderately low, and natural fertility is low.

These soils are better suited to crop production than any other ones in Arthur and Grant Counties, although severe hazards for cropland are present. Soil blowing is the main hazard.

Crops that produce lots of residue, principally rye and hay, are well suited to soils in this unit. Corn and sorghum need to be managed so that the maximum residue remains on the soil surface to reduce soil blowing in spring and winter. Conservation tillage, stripcropping, and growing cover crops help to prevent soil blowing. Grazing of the residues by livestock should not be permitted.

Alfalfa responds to phosphate fertilizers. Irrigated grain and row crops respond to nitrogen and phosphorus. Sulfur applications increase hay production in some areas. Alfalfa for hay is the dominant crop on both dryland and irrigated soils.

Most of the acreage is in native grass. Some areas are mowed for hay, but most are grazed. The grazed areas need a good range management program that includes proper grazing use, deferred grazing, or a planned grazing system. A grassland management principle of "take half and leave half" of key species is applicable on rangeland of this unit. More uniform grazing can be obtained by proper placement of fences, salt, and water.

CAPABILITY UNIT IVw-5

Elsmere loamy fine sand, 0 to 3 percent slopes, is the only soil in this capability unit. It is a deep, somewhat poorly drained soil. The texture is loamy fine sand in the surface layer and fine sand in the underlying material. This soil is on the bottoms of wet meadows and on the lower side slopes leading to them where the water table is at a depth of 2 feet early in spring to 5 feet early in fall.

Permeability of this soil is rapid and available water capacity is low. Water intake is rapid and runoff is slow. The content of the organic matter is in the moderate range, and natural fertility is low.

Damage from soil blowing can occur during dry seasons, especially if crop residues are removed. This soil is suited to alfalfa and to mixtures of alfalfa and grass. Additional soil moisture is available from the moderately high water table for these deep-rooted crops. Commercial fertilizers can be used to supply needed nutrients. Alfalfa responds to additions of phosphorus and, in some instances, of sulfur and lime. Irrigated corn and dryland rye are also suited to this soil.

On irrigated land, the sprinkler system is best used. Irrigation water needs to be applied frequently and in light applications to prevent waterlogging early in the season and leaching of plant nutrients when the water table is lowest. Soil blowing can be controlled by using a stubble mulch system, by returning crop residues to the soil, and by planting close-growing crops.

Where this soil is in native grass, most of the grass is mowed for hay. Legumes can be encouraged in the meadows by using phosphate fertilizer. Where this soil is used for range, proper grazing use and deferred grazing or a planned grazing system will encourage the increase of deep-rooted grasses to take advantage of the moderately deep water table.

CAPABILITY UNIT Vw-7

This unit consists of deep, nearly level and very gently sloping soils where the water table is above the surface early in spring. It recedes to a depth of about 3 feet early in fall. These soils are poorly drained and very poorly drained. The surface layer is fine sandy loam or loamy fine sand, and the underlying material is fine sand. They are on the bottoms and the lower parts of valley sides.

Permeability in these soils ranges from moderately rapid to rapid. Available water capacity is low or moderate. The water intake rate is rapid, and runoff is slow or ponded. Organic-matter content is moderate or moderately low, and natural fertility is low or medium.

These soils are too wet for cultivation of the commonly grown crops. They are used principally for hay. However, the water table is so high during wet years that they are difficult to mow for hay production. Bogs commonly form in these soils if they are grazed by cattle when the water table is at or above the surface.

Other than good range management, no special practices are required for pasture or hay crops. Grazing needs to be controlled when the soil is wet to avoid damage by compaction and trampling. Stocking rates and haying operations need to be regulated to allow for vigorous growth of the grasses. Commercial fertilizers applied in field tests have not produced consistent profitable returns. During some years and on some soils, the addition of phosphate has increased growth. Spraying will control undesirable weeds in troublesome areas.

Mowing needs to be regulated so that the grasses remain vigorous and healthy when these soils are used for hayland. In order to allow for some reseeding of the vegetation in meadows, the large areas can be divided into three parts and mowed in a rotation pattern. One-third should be mowed about two weeks before the plants enter the boot stage, one-third at seeding time, and one-third two weeks after seeding has begun. The areas can be rotated in successive years. If a rancher has plenty of hay, the entire area can be rested one year in three, particularly if the rotation mowing plan is not followed. It is desirable that good range grasses reseed themselves in order for them to keep their place in the meadow.

Some grasses can maintain vigor and spread without going to seed. A proper mowing sequence should be followed. Most ranchers mow before the seed is in the boot stage or after seed has matured. Mowing should be avoided between boot stage and seed maturity. After frost and during winter, range animals must be removed before frost moves out of the soil and the water table reaches a high level.

Most of the small areas are grazed with the adjacent larger areas of upland soils. A program of proper grazing use and a planned grazing system is needed for these areas. Proper placement of fences, salt, and water will help to achieve uniform grazing. Mowing or spraying will control undesirable weeds.

CAPABILITY UNIT VIe-5

This unit consists of deep, nearly level to rolling soils. These soils are well drained or excessively drained. They have a surface layer and underlying material of fine sand or loamy fine sand, and they occur on rolling sandhills and in dry valleys.

These soils have rapid permeability and low available water capacity. Water intake is rapid and runoff is generally slow. Organic-matter content is low or moderately low, and natural fertility is low.

These soils are not suited to dryland cultivation because of the hazard of soil blowing when the grass cover is removed during preparation of the seedbed.

Soils that have slopes of 3 to 6 percent are suitable for corn production under sprinkler irrigation systems, if a high level of management is used. Alfalfa and grass grown for hay and pasture are suited to these soils when sprinkler irrigated, provided commercial fertilizers are used and management practices maintain a good grass cover on the soil surface at all times. To obtain maximum crop residue cover, removal of the crop for silage should be limited and grazing of the corn stalks should be restricted.

Applications of irrigation water need to be frequent because of the low available water capacity of these soils. The center pivot type of sprinkler system is the most common type used on these soils.

Blowouts in the range areas need to be fenced to exclude livestock. The areas can then be shaped and reseeded. A mulch will hold the seed in place while it becomes established. The fence is commonly maintained around the area to keep stock from overgrazing the newly established grass.

A program of proper grazing use and a planned grazing system is needed on most of the rangeland in this unit. These will help to keep the grasses vigorous and will support the maximum numbers of livestock without damage to the range.

CAPABILITY UNIT VIs-1

This unit consists of soils that are strongly or very strongly saline-alkali above a depth of 18 inches. They are deep, poorly or somewhat poorly drained soils and have a water table at a depth of 1 foot early in spring and 5 feet early in fall. The texture of the surface layer ranges from fine sandy loam to fine sand. In places there is a sandy clay loam subsoil. The underlying material is mainly fine sand. These soils are nearly level or very gently sloping and occur on the bottoms of wet valleys and on the lower side slopes leading to them.

Permeability of these soils ranges from moderate to rapid. Available water capacity is low because the alkalinity lowers the availability of many nutrients in the soil. Water intake rate is moderately high or only moderate. Runoff is slow. Organic-matter content is low, and natural fertility is low.

These soils are not suited to cultivated crops because of the saline-alkali condition. They are better suited to the grazing of livestock or to hay production than to other uses.

Most of the acreage of these soils is in native grass. Lowering the water table by drainage ditches or tile is generally not possible because of lack of outlets. The alkaline and saline problem is not easily controlled. Most ranchers use these areas as a part of their total grazing program, making allowances as needed in the stocking rate and mowing pattern to accommodate to the saline-alkali soil conditions. In some areas grass production is more than that of the adjacent Valentine soil areas. Grass production is generally lower, however, in those areas where the soils are not affected by alkalinity. A common use for the areas in native grass is to mow the grass for hay late in summer and to use the crop for winter feed.

Where the grass is grazed, the most needed conservation practices are proper grazing use and a planned grazing system. These will maintain or improve both the quality and quantity of desirable vegetation. Proper fencing, salting, and placing of watering facilities help to achieve uniform grazing. A good range management system will control most weeds. Troublesome areas may need to be sprayed.

CAPABILITY UNIT VIw-5

Els fine sand, 0 to 3 percent slopes, is the only soil in this capability unit. It is a deep, somewhat poorly drained soil. The underlying material is fine sand. The soil is on the bottoms and the lower parts of wet valleys where the water table is at a depth of 2 or 3 feet in spring to 5 feet early in fall.

This soil has rapid permeability and low available water capacity. Water intake is rapid and runoff is slow. Content of organic matter and natural fertility are low.

This soil is not suited to the commonly cultivated dryland crops. It is too coarse textured and the hazard of soil blowing is very severe when the soil is dry. It is used mostly for the production of hay. A few small areas are grazed.

Field trials with phosphate fertilizer have not given consistently adequate returns. Alsike clover can be succeessfully established on some of the better drained areas.

This soil can be used for irrigated corn and alfalfa. Adequate applications of fertilizer are needed to maintain fertility. Soil blowing is a severe hazard. Keeping crop residue on the surface of the soil will help to control the blowing. The soil warms up late in the spring; in some years it is too wet for timely spring tillage. Applications of irrigation water need to be light and frequent, particularly in summer when the water table is lowest and when the surface layer tends to dry rapidly in the summer heat.

When this soil is used for hayland, mowing needs to be regulated so that the grasses remain vigorous and healthy. In order to allow for some reseeding of the vegetation in meadows, the large areas can be divided into three parts and mowed in a rotation pattern. One-third should be mowed about two weeks before the plants enter the boot stage, one-third at seeding time, and one-third two weeks after seeding has begun. The areas can be rotated in successive years. If a rancher has plenty of hay, the entire area may be left idle one year in three, particularly if the rotation mowing plan is not followed. It is desirable that good range grasses reseed themselves in order for them to keep their place in the meadow.

Some grasses can maintain vigor and spread without going to seed. A proper mowing sequence should be followed. Most ranchers mow before the seed is in the boot stage or after seed has matured. Mowing should be avoided between boot stage and seed maturity. After frost and during winter, range animals can graze the meadows without damage, if the areas are properly stocked.

Most of the small areas are grazed with the adjacent larger areas of upland soils. A program of proper grazing use and a planned grazing system is needed for these areas. Proper placement of fences, salt, and water will help to achieve uniform grazing. A good range management system will control most weeds, but troublesome areas may need to be sprayed.

CAPABILITY UNIT VIIe-5

This unit consists of hilly and rolling soils that are in a complex landscape pattern. These deep, excessively drained soils are fine sand throughout the profile. This unit includes the highest and roughest dunes in the survey area.

These soils have rapid permeability and low available water capacity. Water intake is rapid and runoff is slow to medium. Organic-matter content and fertility are low.

These soils are too sandy and too steep for the commonly cultivated crops. Soil blowing is a very severe hazard. Maintaining good stands of native grass will control erosion by wind and water. A range management program that includes proper grazing use, deferred grazing, and a planned grazing system is needed on nearly all this land.

Blowouts need to be fenced to keep out livestock. The areas can then be shaped before seeding and mulching.

Care needs to be taken that the soil does not begin to blow again after the grass is reestablished.

CAPABILITY UNIT VIIIw-7

This capability unit consists of the Marsh mapping unit. Marsh occurs on nearly level areas on the bottoms of valleys and along the shores of some lakes. Soil material in Marsh ranges from fine sand to fine sandy loam and includes organic layers in many places. Water is generally above the surface except during occasional extended dry periods. Marsh is frequently flooded. It is too wet to be used successfully for hay or pasture. Vegetation consists mainly of cattails, rushes, arrowheads, and burreed.

This land type is better suited to habitat for wetland wildlife than to other uses. Waterfowl and muskrats make use of Marsh areas. The natural vegetation, however, is not used for grazing by domestic animals.

Predicted yields

Crop yield predictions are an important interpretation that can be made from a soil survey. The predicted acre yields for the principal crops grown on soils of Arthur and Grant Counties are given in table 2. These predictions are based on average yields for seeded acres over the most recent 5-year period. They do not represent anticipated yields that might be obtainable in the future under a new and possibly different technology.

Yields for various crops were derived from information obtained from interviews with farmers, directors of the Natural Resources Districts, representatives of the Soil Conservation Service and Agricultural Extension Service, and others familiar with the soils and farming in the counties. Yield records, trends, research, and experience were taken into consideration.

Crop yields are influenced by many factors, such as the soil features of depth, texture, slope, and drainage. Also important are erosion, available water capacity, permeability, and fertility. Management practices such as the cropping pattern, timeliness of operations, plant population, and crop variety have an effect on crop yields. Finally, weather is significant both on a day-to-day basis and on a longer seasonal or yearly basis. All these factors were taken into account when preparing table 2.

The yields listed are those predicted under a high level of management. Such management represents those practices used by the most successful ranchers or farmers in the counties. Under this level of management, fertility is maintained and fertilizer or lime is applied at rates indicated by soil tests and field experiments. Crop residues are returned to the soil to improve tilth and to maintain or to increase soil organic-matter content. Adapted varieties of seed are used and plant populations are optimum. Weeds, insects, and diseases are well controlled. Under irrigation, water is applied in a timely manner and in the proper amounts. Water erosion and soil blowing are controlled. Where needed for crop production, the soil is drained. Tillage and seeding practices are performed at the proper time and are adequate. The soil is protected from deterioration and used in accordance with its capacity.

One of the best uses for the yield table is to compare the productivity of one soil to that of other soils within the counties. The table in no sense gives recommendations, and the yields given do not apply to specific farms, ranches, or operators.

Yields in any one year on a particular soil may vary considerably from the figures given. The difference can be caused by the weather, diseases, insects, or unpredictable hazards. By using long-time averages, it is possible to take into consideration such hazards in predicting crop yields.

Use of the Soils for Range [3]

Rangeland amounts to approximately 98 percent of the total farm acreage in Arthur and Grant Counties. This rangeland, for the most part occurring on sandy uplands, is generally not suitable for cultivation. The major soil associations are Valentine-Gannett-Elmsere and Valentine. (See general soil map.)

The raising of livestock—mainly cow-calf herds, with the calves sold in the fall as feeders—is the largest farm industry in these counties. The range is grazed 8 to 10 months each year. Native hay is fed the remainder of the year.

[3] By PETER N. JENSEN, range conservationist, Soil Conservation Service.

TABLE 2.—*Predicted average yields per acre of principal crops*

[Yields are those predicted for arable soils when the crop is grown under a high level of management. Absence of a figure indicates the crop is not suited to the soil, is not commonly grown, or that dryland management is not practical]

Mapping unit	Irrigated corn	Dryland rye	Alfalfa	
			Dryland	Irrigated
	Bu	*Bu*	*Tons*	*Tons*
Doger and Dunday loamy fine sands, 0 to 3 percent slopes	120	15	1.2	4.0
Doger and Dunday loamy fine sands, 3 to 9 percent slopes	100			3.2
Doger and Dunday loamy fine sands, loamy substratum, 0 to 3 percent slopes	130	25	1.8	4.5
Els fine sand, 0 to 3 percent slopes	80			3.0
Elsmere loamy fine sand, 0 to 3 percent slopes	90	18	2.0	3.8
Valentine fine sand, 0 to 3 percent slopes	90			3.2

Management and improvement practices

Management practices that maintain or improve the range condition are needed on all rangeland, regardless of other practices used. These are (a) *proper grazing use* (fig. 12), or grazing at an intensity that will maintain enough cover to protect the soil and maintain or improve the quantity and quality of desirable vegetation; (b) *deferred grazing,* or postponing grazing or resting grazing land for a prescribed period; and (c) *planned grazing systems,* or systems in which two or more grazing units are alternately rested from grazing in a planned sequence over a period of years, the rest period being either throughout the year or during the growing season of the key plants.

The proper distribution of livestock in a pasture can be improved by proper location of (a) fences, (b) salting facilities, and (c) livestock water developments (fig. 13).

Practices that improve the range condition include range seeding. This is the establishment by seeding or reseeding of native grasses, using seed obtained by either wild harvest or improved strains on land suitable for use as range. There are approximately 50,000 acres of abandoned cropland in Arthur and Grant Counties that should be range seeded. The most important grasses used in the seed mixture include sand bluestem, little bluestem, switchgrass, indiangrass, prairie sandreed, sand lovegrass, and blue grama. Little care other than management of grazing is needed to maintain forage production.

Range sites and condition classes

Different kinds of range produce different kinds and amounts of native grass. For proper range management, an operator should know the different kinds of land or range sites in his holding and the native plants each site can grow. Management that favors the growth of the best forage plants on each kind of soil can then be used.

Range sites are distinctive kinds of rangeland that differ from one another in their ability to produce a significantly different kind, proportion, or production of climax, or original, vegetation. A significant difference is one great enough to require some variation in management, such as a different stocking rate. Climax vegetation is the combination of plants that originally grew on a given site. The most productive combination of range plants on a site generally is the climax type of vegetation.

Range condition is classified according to the percentage of the original, or climax, vegetation. This classification is used for comparing the kind and amount of present vegetation with that which the site can produce. Changes in range condition are caused primarily by the intensity of grazing and by drought.

Climax vegetation may be altered by intensive graz-

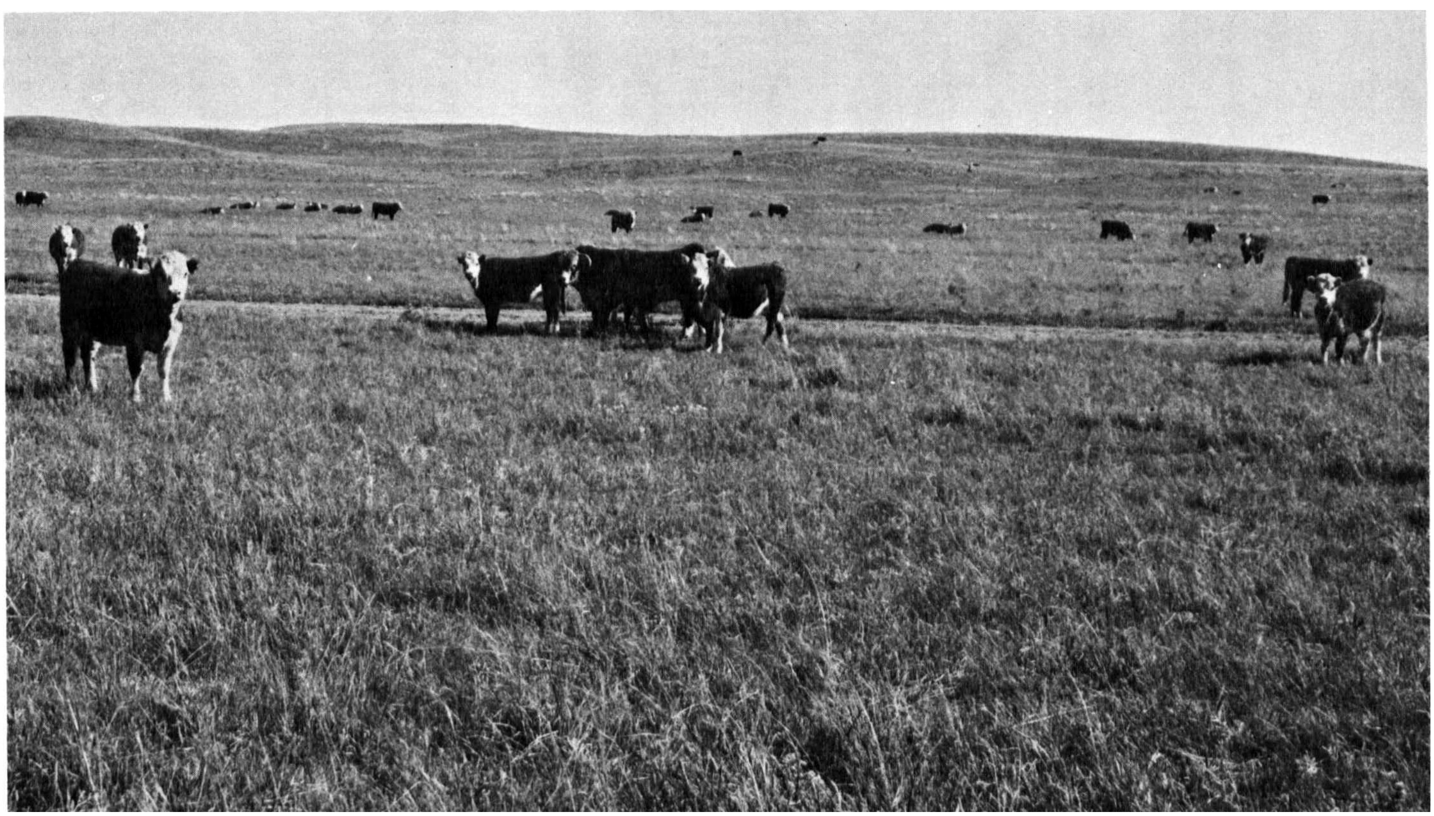


Figure 12.—**Proper grazing use is the most important conservation practice used by ranchers. It requires that cattle remove not more than half, by weight, of the total annual production.**

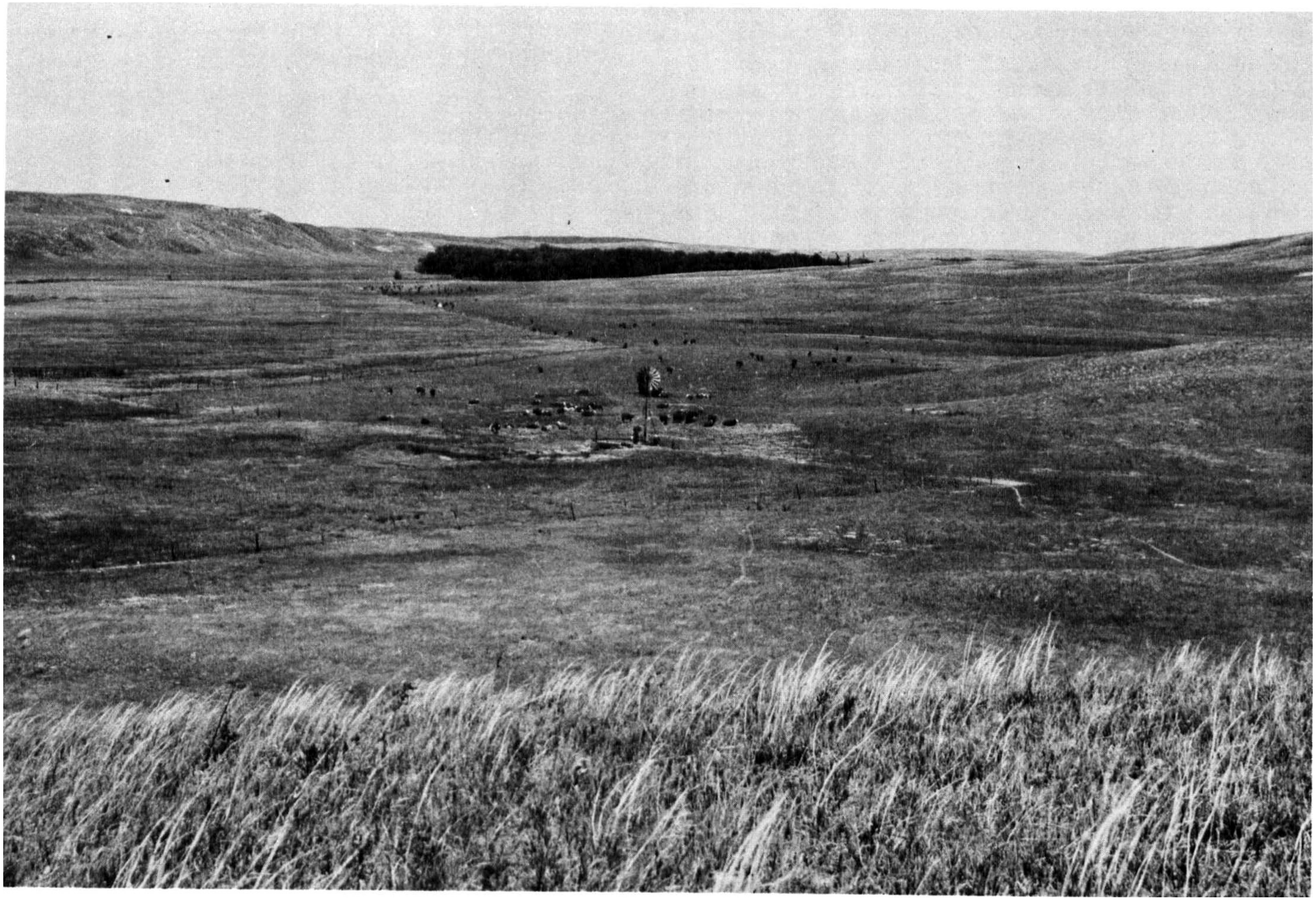


Figure 13.—**Proper location of livestock wells help to distribute grazing.**

ing. Livestock graze selectively. They constantly seek the more palatable and nutritious plants. Plants react to grazing in one of three ways—by decreasing, increasing, or invading. Decreaser and increaser plants are climax plants. Generally, *decreasers* are the most heavily grazed and, consequently, the first to be injured by overgrazing. *Increasers* withstand grazing better or are less palatable to the livestock. They increase under grazing and replace the decreasers. *Invaders* are weeds that become established after the climax vegetation has been reduced by grazing.

Range condition is expressed in four condition classes that show the present state of the vegetation on a range site in relation to the vegetation that grew on it originally. The condition is *excellent* if 76 to 100 percent of the vegetation is climax; *good* if 51 to 75 percent is climax; *fair* if 26 to 50 percent is climax; and *poor* if 0 to 25 percent is climax.

Descriptions of range sites

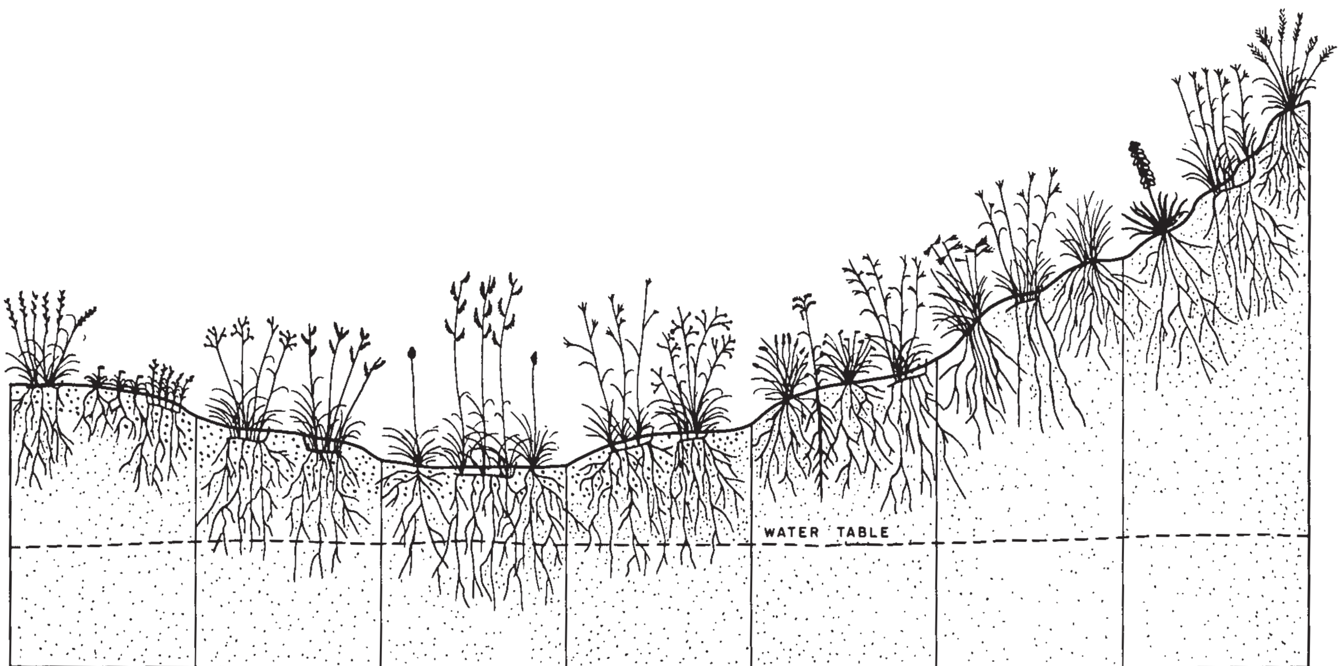
The range sites in Arthur and Grant Counties are Wet Land, Subirrigated, Saline Subirrigated, Saline Lowland, Sandy, Sands, and Choppy Sands (fig. 14). These range sites are described in this section. The descriptions include (1) the topography in each site, (2) the soils in each site, (3) the dominant vegetation when the site is in excellent condition, (4) the dominant vegetation when the site is in poor condition, and (5) the total annual yield of air-dry forage in pounds per acre under favorable and unfavorable growing conditions.

To find the names of all the soils in any range site, refer to the "Guide to Mapping Units" at the back of this survey. Similarly, the range site or sites that occur in each soil mapping unit can be determined by referring to the "Guide to Mapping Units." Marsh is not assigned to a range site because this land is not used for range purposes.

WET LAND RANGE SITE

This site consists of poorly drained soils that are ponded for a significant part of the growing season during most years. The water table is above the ground surface early in spring and at a depth of about 2 feet early in fall. The soils of this site are deep and have a surface layer of fine sandy loam to loamy fine sand. The underlying material is fine sand. These soils are nearly level. The very high water table determines primarily the kind of vegetation that grows on this site.

The climax plant cover is a mixture of such de-



Range Site	Saline Lowland	Saline Subirrigated	Wet Land	Subirrigated	Sandy	Sands	Choppy Sands
Soil Series or Land Types	Els, alkali	Saline-alkali land	Gannett-Loup	Elsmere	Doger-Dunday	Valentine, rolling	Valentine, hilly

***Figure 14.*—Range sites in Arthur and Grant Counties and representative soils in each.**

creaser grasses as prairie cordgrass, Canada wildrye, slender wheatgrass, and various reedgrasses, all of which make up at least 70 percent of the total plant production. Other perennial grasslike plants and forbs account for the remaining 30 percent. Plains bluegrass and members of the sedge family are the principal increasers.

When the site is in poor range condition, the typical plant community consists of Kentucky bluegrass, redtop threeawn, red clover, foxtail barley, alsike clover, dandelion, inland saltgrass, yellow sweetclover, sparse amounts of prairie cordgrass, and members of the sedge family.

When the site is in excellent range condition, the total annual yield of air-dry forage ranges from 4,500 pounds per acre in unfavorable years to 5,500 pounds in favorable years.

SUBIRRIGATED RANGE SITE

This site consists of deep, somewhat poorly drained soils that have a water table at a depth of 3 to 5 feet and of poorly drained soils that have a water table at a depth of 1 to 3 feet during the growing season. The surface layer ranges from fine sandy loam to fine sand, and the underlying material is fine sand. These soils are nearly level to very gently sloping. Reaction in the surface layer ranges from neutral to moderately alkaline. The moderately high water table determines primarily the kind of vegetation that grows on this site.

The climax plant cover is a mixture of such decreaser grasses as big bluestem, little bluestem, switchgrass, prairie cordgrass, reed canarygrass, and slender wheatgrass, all of which make up at least 70 percent of the total plant volume. Other perennial grasses and forbs account for the remaining 30 percent. Kentucky bluegrass, western wheatgrass, and members of the sedge family are the principal increasers.

When the site is in poor range condition, the typical plant community consists of Kentucky bluegrass, foxtail barley, dandelion, inland saltgrass, blue grama, western ragweed, sparse amounts of western wheatgrass, and members of the sedge family.

When the site is in excellent range condition, the total annual yield of air-dry forage ranges from 4,000 pounds per acre in unfavorable years to 5,000 pounds in favorable years.

SALINE SUBIRRIGATED RANGE SITE

Saline-Alkali land is the only mapping unit in this site. The soil material is deep, nearly level to very gently sloping, and strongly or very strongly alkaline in reaction. The water table is at a depth of 1 to 3 feet. Soil textures range from fine sandy loam to fine sand in the surface layer. The underlying material is mainly fine sand. The saline-alkali condition and the high water table determine primarily the kind of vegetation that grows on this site.

The climax plant cover is a mixture of such decreaser grasses as alkali cordgrass, switchgrass, nuttal alkaligrass, Canada wildrye, plains bluegrass, and western wheatgrass, all of which make up at least 75 percent of the total plant volume. Other perennial grasses and forbs account for the remaining 25 percent. Inland saltgrass, puffsheath dropseed, and members of the sedge family are the principal increasers.

When the site is in poor range condition, the typical plant community consists of inland saltgrass, Kentucky bluegrass, dandelion, foxtail barley, and various members of the sedge family.

When the site is in excellent range condition, the total annual yield of air-dry forage ranges from 3,500 pounds per acre in unfavorable years to 4,500 pounds in favorable years.

SALINE LOWLAND RANGE SITE

Els loamy fine sand, alkali, 0 to 3 percent slopes, is the only soil in this site. It is on bottom lands and in depressions where the water table is at a depth of 2 to 5 feet during the growing season. The surface layer is loamy fine sand, and the underlying material is fine sand. The soil is strongly or very strongly alkaline from a depth of 6 to 18 inches downward to the seasonal high water table. The soil alkalinity and the moderately high water table determine primarily the kind of vegetation that grows on this site.

The climax plant cover is a mixture of such decreaser grasses as alkali sacaton, switchgrass, western wheatgrass, slender wheatgrass, and plains bluegrass, all of which make up at least 50 percent of the total plant volume. Other perennial grasses and forbs account for the remaining 50 percent. Inland saltgrass, blue grama, Kentucky bluegrass, puffsheath dropseed, needleandthread, sand dropseed, and members of the sedge family are the principal increasers.

When the site is in poor range condition, the typical plant community consists of inland saltgrass, blue grama, sand dropseed, Kentucky bluegrass, and various members of the sedge family.

When the site is in excellent range condition, the total annual yield of air-dry forage ranges from a low of 2,500 pounds per acre in unfavorable years to 3,500 pounds in favorable years.

SANDY RANGE SITE

This site is made up of nearly level to very gently sloping soils that have a fine sand surface layer and nearly level to strongly sloping soils that have a loamy fine sand surface layer. They are deep, well-drained and excessively drained soils. The underlying material ranges from loamy fine sand to fine sand. In places there is loamy material below a depth of 3 feet. These soils occur mainly in dry valleys. The gently sloping topography determines primarily the kind of vegetation that grows on this site.

The climax plant cover is a mixture of such decreaser plants as sand bluestem, little bluestem, switchgrass, prairie junegrass, and leadplant, which make up at least 50 percent of the total plant volume. Other perennial grasses and forbs account for the remaining 50 percent. Blue grama, prairie sandreed, needleandthread, purple lovegrass, western wheatgrass, and sand dropseed are the principal increasers.

When the site is in poor range condition, the typical plant community consists of blue grama, hairy grama, sand dropseed, western ragweed, sixweeks fescue, and annual bromes.

When the site is in excellent range condition, the total annual yield of air-dry forage ranges from 1,250 pounds per acre in unfavorable years to 2,500 pounds in favorable years.

SANDS RANGE SITE

This site consists of deep, excessively drained soils on uplands that have rolling topography. The soils have a fine sand surface layer and fine sand underlying material. The slopes are complex and range from 3 to 17 percent. The deep storage of moisture in these coarse-textured soils determines primarily the kind of vegetation that grows on this site.

The climax plant cover is a mixture of such decreaser plants as sand bluestem, switchgrass, prairie junegrass, and leadplant, which make up at least 50 percent of the total plant volume. Other perennial grasses, forbs, and shrubs account for the remaining 50 percent. Blue grama, little bluestem, prairie, sandreed, needleandthread, sand paspalum, purple lovegrass, Scribner panicum, sand dropseed, brittle pricklypear, cudweed sagewort, Arkansas rose, small soapweed, and members of the sedge family are the principal increasers.

When the site is in poor range condition, the typical plant community consists of blue grama, hairy grama, sand paspalum, Scribner panicum, western ragweed, and small soapweed.

When the site is in excellent range condition, the total annual yield of air-dry forage ranges from 1,500 pounds per acre in unfavorable years to 2,500 pounds in favorable years.

CHOPPY SANDS RANGE SITE

This site consists of deep, excessively drained soils on uplands that have hilly topography. The soil material is loose, and the soils have a surface layer and underlying material of fine sand. The slopes are complex and range from 17 to 60 percent. The steep slope of these coarse-textured soils determines primarily the kind of vegetation that grows on this site.

The climax plant cover is a mixture of such decreaser plants as sand bluestem, sand lovegrass, switchgrass, blowoutgrass, and Canada wildrye, all of which make up at least 70 percent of the total plant volume. Other perennial grasses, forbs, and shrubs account for the remaining 30 percent. Prairie sandreed, little bluestem, needleandthread, hairy grama, sand dropseed, Arkansas rose, small soapweed, and members of the sedge family are the principal increasers.

When the site is in poor range condition, the typical plant community consists of sandhill muhly, sand paspalum, sand dropseed, hairy grama, and small soapweed.

When the site is in excellent range condition, the total annual yield of air-dry forage ranges from 1,500 pounds per acre in unfavorable years to 2,500 pounds in favorable years.

The following list gives the scientific names for those common names that are used in the description of the range sites:

Common Name	*Scientific Name*
Alkali cordgrass	*Spartina gracilis Trin.*
Alsike clover	*Trifolium hybridum L.*
Annual bromes	*Bromus spp. L.*
Arkansas rose	*Rosa arkansana Porter*
Big bluestem	*Andropogon gerardi Vitman*
Blowoutgrass	*Redfieldia flexuosa (Thurb.) Vasey*
Blue grama	*Bouteloua gracilis CH.B.U. (Lag. ex Stend.)*
Brittle pricklypear	*Opuntia fragilis (Nutt.) Haw.*
Canada wildrye	*Elymus canadensis L.*
Common pricklypear	*Opuntia compressa (Salisb.)*
Cudweed sagewort	*Artemisia ludoviciana var. gnophalodes (Nutt.) T. & G.*
Dandelion	*Taraxacum officinale Deber in Wiggers*
Foxtail barley	*Hordeum jubatum L.*
Hairy grama	*Bouteloua hirsuta Lag.*
Inland saltgrass	*Distichlis stricta (Torr.) Rydb.*
Kentucky bluegrass	*Poa pratensis L.*
Leadplant	*Amorpha canescens Pursh*
Little bluestem	*Andropogon scoparius Michx.*
Needleandthread	*Stipa comata Trin. and Rupr.*
Nuttall alkaligrass	*Puccinellia airoides (Nutt.) Wats and Coult.*
Plains bluegrass	*Poa arida Vasey*
Prairie cordgrass	*Spartina pectinata Link*
Prairie junegrass	*Koeleria cristata (L.) Pers.*
Prairie sandreed	*Calamovilfa longifolia (Hook.) Scribn.*
Puffsheath dropseed	*Sporobulus neglectus Nash*
Purple lovegrass	*Eragrostis spectabilis (Pursh) Stend.*
Redtop	*Agrostis alba L.*
Red clover	*Trifolium pratense L.*
Reedgrasses	*Calamagrostis spp. Adans.*
Reed canarygrass	*Phalaris arundinacea L.*
Sand bluestem	*Andropogon Hallii Hack.*
Sand dropseed	*Sporobolus cryptandrus (Torr.) Gray*
Sand lovegrass	*Eragrostis trichodes (Nutt.) Wood*
Sand paspalum	*Paspalum stramineum Nash*
Sandhill muhly	*Muhlenbergia pungens Thurb.*
Scribner panicum	*Panicum scribnerianum Nash*
Sedges	*Carex spp. L.*
Sixweeks fescue	*Festuca octoflora Walt.*
Slender wheatgrass	*Agropyron trachycaulum (Link) Malte*
Small soapweed	*Yucca glauca Nutt.*
Switchgrass	*Panicum virgatum L.*
Western ragweed	*Ambrosia psilostachya DC*
Western wheatgrass	*Agropyron smithii Rydb.*
Yellow sweetclover	*Melilotus officinalis (L.) Lam.*

Use of the Soils for Windbreaks [4]

The few native trees that grow in Arthur and Grant Counties occur chiefly on bottom lands and in natural depressions. Because of their small number and limited growth, trees in natural woodlands of Arthur and Grant Counties have little commercial value. Early settlers planted trees for shade, for fenceposts, and as windbreaks to protect their homes. Throughout the years landowners have continued to plant trees to protect buildings, livestock, and soils. Native trees and shrubs contribute a great deal to the natural beauty of the landscape in Arthur and Grant Counties. Their presence benefits wildlife by producing food and cover.

Kinds of windbreaks

The most important use for trees in Arthur and Grant Counties is for windbreaks. Because of the scarcity of native trees and the severe extremes of weather that prevail, windbreaks are needed for farmstead and livestock protection. The landowner who plants a windbreak is well paid for his time and expense. Windbreaks help to reduce home heating costs, control drifting of snow, provide shelter for livestock (fig. 15), and improve conditions for wildlife.

While trees are not easily established in these counties, observing basic rules of tree culture can result in a fairly high degree of tree survival. Healthy seedlings properly planted on a prepared soil site and maintained in good condition can survive and grow well. However, they require care after planting if they are to continue to survive.

Trees and shrubs in windbreaks need protection from livestock and fire. Seedlings need protection from rabbits and mice. Additional information on design, planting, and care of windbreaks is available from the Soil Conservation Service and the Agricultural Extension Service forester serving these counties.

Growth of trees

The conifers, cedar, pine, and Rocky Mountain juniper are best suited for windbreaks in Arthur and Grant Counties. Measurements show that eastern redcedar and ponderosa pine, both native to Nebraska, are the most reliable windbreak species. Both rated high in survival and vigor in studies that were made. These species hold their leaves through the winter, giving maximum protection when it is most needed. Several broadleaf species are also well suited for use as windbreaks in these counties.

Eastern redcedar can reach a height of about 25 feet at maturity. Rocky Mountain juniper attains a slightly lower height at maturity. Ponderosa pine grows slightly faster and is somewhat taller than these trees at maturity. The same is true of broadleaf trees.

The rate of tree growth in a windbreak varies widely with soil moisture conditions and soil fertility. Exposure and arrangement of trees within the planting also have a marked effect on growth. Some species grow faster than others; some make an early, fast growth but tend to die young. This is occasionally true of eastern cottonwood. Siberian elm and Russian-olive are vigorous early growers. They can, however, spread where they are not wanted and can be short-lived. Boxelder and Russian mulberry commonly freeze back in severe winters and green ash is susceptible to damage by borers.

Windbreak suitability groups

Soils of Arthur and Grant Counties are grouped according to characteristics that affect tree growth. To find the name of all soils in any group, refer to the "Guide to Mapping Units" at the back of the survey. Soils in a group produce similar growth and survival under normal conditions of weather and care.

Soils in Nebraska are grouped in windbreak suitability groups according to a statewide system. Not all groups are in Arthur and Grant Counties. Each of the following descriptions of the windbreak suitability groups in these counties lists trees and shrubs that are suitable for windbreak plantings in that group. Also

[4] By JAMES W. CARR, JR., forester, Soil Conservation Service.

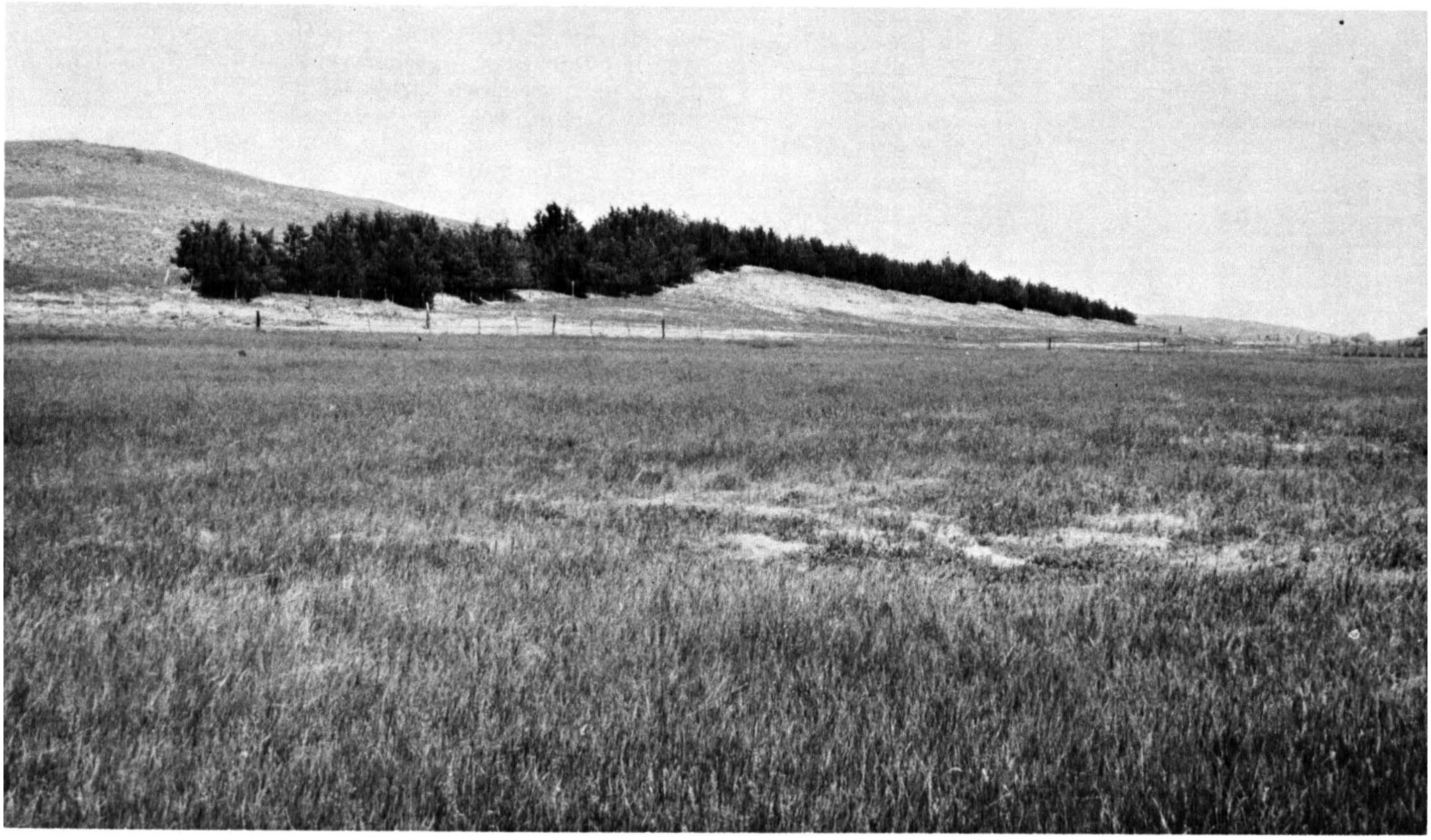


Figure 15.—**A windbreak of eastern redcedar designed to protect in a winter feeding area. The trees are planted in Valentine fine sand, rolling.**

given are approximate rates of tree growth and the mature heights for important species.

WINDBREAK SUITABILITY GROUP 2

This group consists of soils that have a water table at a depth of 1 or 2 feet in spring and 5 feet early in fall. The surface layer is loamy fine sand or fine sand, and the underlying material is fine sand. The soils of this group are deep and somewhat poorly drained. They are nearly level or very gently sloping and are on valley bottoms or the lower parts of valley sides. These soils are neutral to moderately alkaline throughout their profile.

The soils of this group have rapid permeability and low to moderate available water capacity. Surface intake is rapid and runoff is slow. Content of organic matter is low or moderate, and natural fertility is low.

These soils provide a good tree-planting site with capability for good survival and growth if the species selected are those that can tolerate occasional wetness. Establishment of seedlings is a problem at times during wet years. Also, the abundant and persistent herbaceous vegetation that grows on these sites is a concern in the management and establishment of trees.

Trees and shrubs suitable for planting are:

Conifers: eastern redcedar, Austrian pine, and Scotch pine.

Medium to tall broadleaf trees: Siberian elm, golden willow, white willow, and eastern cottonwood.

Shrubs: redosier dogwood, common chokecherry, and silver buffaloberry.

Austrian pine and Scotch pine grow slightly more than 1 foot a year in these soils. They have a mature height of about 45 feet. Eastern redcedar grows slightly less than 1 foot each year and has a mature height of about 25 feet. Eastern cottonwood grows a little less than 3 feet each year and attains a mature height of about 55 to 60 feet. Siberian elm and willows grow slightly less than $1\frac{1}{2}$ feet a year, attaining a mature height of about 35 to 40 feet.

WINDBREAK SUITABILITY GROUP 3

This group consists of deep, well-drained soils. They are nearly level to gently sloping. The texture of the surface layer is loamy fine sand. The underlying material is loamy fine sand and fine sand, but in a few places there is a fine sandy loam substratum. These soils are on valley bottoms and lower parts of valley sides. The surface layer is neutral in reaction.

These soils have rapid permeability and low or moderate available water capacity. Surface intake of moisture is rapid and runoff is slow. Organic-matter content is moderately low and natural fertility is low.

These soils are suited to tree planting if soil blowing is prevented. This can be done by maintaining strips of sod or other vegetation between the rows. Drought and competition for moisture from weeds and grass are also hazards. Water erosion can be a hazard on the gently to moderately sloping soils.

Trees and shrubs suitable for planting are:

Conifers: eastern redcedar, Rocky Mountain juniper, pondersoa pine, Austrian pine, and Scotch pine.
Low broadleaf trees: Russian mulberry.
Medium to tall broadleaf trees: honeylocust, green ash, Siberian elm, and eastern cottonwood.
Shrubs: skunkbush sumac, lilac, common chokecherry, and American plum.

On soils of this group, eastern redcedar grows slightly less than 1 foot a year and attains a mature height of about 25 feet. Rocky Mountain juniper grows slightly slower than this and has a somewhat lower mature height. Ponderosa pine, Austrian pine, and Scotch pine grow approximately 1¼ feet a year and attain a mature height of about 50 feet. Eastern cottonwood can grow 2½ feet a year and reach a height of 50 to 55 feet. Siberian elm can grow 1½ feet a year and reach a mature height of 35 to 40 feet. Honey locust and green ash can grow slightly more than 1 foot a year and reach an approximate mature height of 25 to 30 feet.

WINDBREAK SUITABILITY GROUP 6

This group consists of deep, nearly level or very gently sloping soils that have a water table above the ground surface early in spring and at a depth of about 3 feet early in fall. The soil reaction is neutral to moderately alkaline in the surface layer. The texture of the surface layer ranges from fine sandy loam to fine sand. These soils are on the bottoms and the lower sides of valleys. The soils are poorly drained.

These soils have rapid or moderately rapid permeability and low or moderate available water capacity. Surface intake of moisture is rapid, and runoff is slow or ponded. The organic-matter content is moderately low or moderate, and natural fertility ranges from low to medium. Wetness from the high water table is the principal hazard and a prime management concern. Only those trees and shrubs that are tolerant of a high water table are suited to these soils. Trees may have to be established in a shallow furrow on these sites since cultivation may be impossible because of wetness.

Trees and shrubs suitable for planting are:

Medium to tall broadleaf trees: golden willow, white willow, and eastern cottonwood.
Shrubs: redosier dogwood.

In soils of this group, eastern cottonwood grows about 2 feet a year and attains a mature height of about 45 to 50 feet. Willows grow slightly over 1 foot a year and reach a height of about 25 to 30 feet.

WINDBREAK SUITABILITY GROUP 7

This group consists of deep, loose soils that have fine sand texture throughout their profile. Reaction is neutral in the surface layer. These soils occur on sandy uplands and in dry valleys. They are nearly level to rolling and they are excessively drained.

These soils have rapid permeability and low available water capacity. Surface intake of moisture is rapid and runoff is slow. Organic-matter content and natural fertility are low.

These soils are so loose that trees need to be planted in shallow furrows and not cultivated. Young seedlings suffer during high winds and may be covered by drifting sand. Only the following conifers are suitable for planting in these soils: eastern redcedar, ponderosa pine, and Austrian pine.

In soils of this group, eastern redcedar grows approximately three-fourths of a foot a year, reaching a mature height of about 15 to 20 feet. Ponderosa pine and Austrian pine grow about 1¼ feet a year and reach a mature height of about 25 to 30 feet.

WINDBREAK SUITABILITY GROUP 10

This group consists of soils that have a wide range of characteristics. These soils occur on the bottoms and the lower sides of valleys as well as on the highest and steepest parts of sandhill ridges. Such soils are either too alkaline, too wet, or too steep for planting trees with machinery.

Soils of this group are generally not suited to windbreak plantings of any kind because of their unfavorable characteristics. Some areas can be used for recreation, forestation, and wildlife plantings of tolerant tree and shrub species if the trees or shrubs are hand planted.

Use of the Soils for Wildlife and Recreation [5]

Wildlife populations in Arthur and Grant Counties are determined largely by the quality and quantity of vegetation that the land is capable of producing. Cover, food, and water in proper combination are the three elements essential to wildlife abundance.

Topography and soil characteristics, such as fertility, play a major role in determining wildlife numbers. Fertile soils produce more and better quality wildlife, both game and nongame species. The primary discussion here is devoted to the game species, although nongame species are becoming increasingly important. When living conditions for the game species are improved, nongame species also benefit.

Appreciation of the natural environment by persons other than hunters and fishermen now has greater importance than ever. This helps people to understand the relationship between plants, animals, and man—and how all are dependent upon the soil.

Wildlife species can be used to evaluate the quality of the environment. It has been rightly said that a livable environment for wildlife is generally a quality environment for man.

In many cases the soils rated highest for wildlife potential do not have the highest wildlife populations. This is not caused by the inability of soils to support wildlife but rather by many other factors such as hunting pressure, clean tillage, and improved harvesting methods. The potential still remains and wildlife values can be enhanced with little cost and effort. Wildlife has a place in both rural and urban settings and needs to be considered when planning for optimum use of these areas. Fishponds that fill by runoff from fertile

[5] By ROBERT O. KOERNER, biologist, Soil Conservation Service.

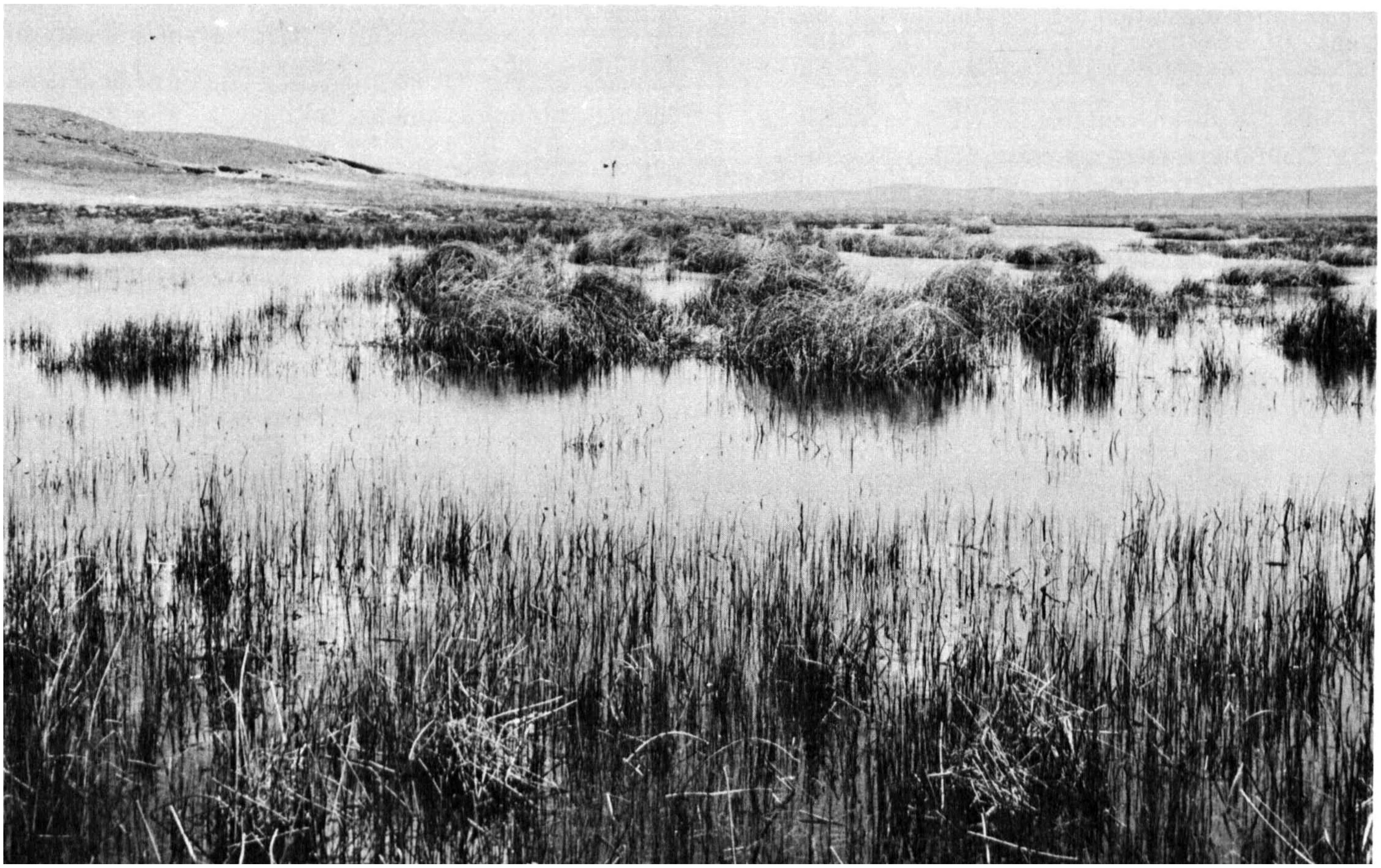


Figure 16.—Areas of Marsh serve as habitat for many water birds in the Sandhills area.

fields usually produce more pounds of fish than the average because of the increased food production.

Kinds of wildlife

The Valentine-Gannett-Elsmere association has a greater diversity in kinds of wildlife than any other association in Arthur and Grant Counties. It is typified by rolling sandhills and wet valleys. Most of the wetland areas and lakes of these counties are in this association.

Pricklypear cactus, yucca, and wild flowers scent and beautify the landscape in spring. Ground water is near or above the surface in the valleys, creating wetlands that have cattails and rushes as well as eastern cottonwood and willow trees.

Many shore birds and other water-loving birds congregate around Marsh areas and lakes in meadows. These include avocets, curlews, sandpipers, phalaropes, great blue herons, American bittern, and white pelicans. Dabbling ducks such as mallards, pintails, green-winged teal, blue-winged teal, shovelers, and coots nest in the grass that surrounds areas of Marsh and water (fig. 16). Mink, muskrat, beaver, raccoon, and weasel also frequent the wetlands where food is available for each of these wildlife species. Many kinds of upland wildlife such as white-tailed deer, mule deer, prairie grouse, fox, coyote, and badger find the water areas welcome in an otherwise dry environment. Since the lakes and Marsh areas generally freeze over before the big fall migration of ducks and geese, much of the waterfowl hunting depends on locally reared ducks.

The Valentine association is primarily in grassland, though it has a few isolated plum and buckbrush thickets. A few scattered wet spots occur, and these generally have willow and cottonwood trees that are good for wildlife cover.

Wildlife of the Valentine association consists mainly of white-tailed deer and mule deer (less than one per square mile), a few antelope (less than one every two square miles), and prairie grouse (five to ten per square mile). There are many jackrabbits, and they provide food for the predators. A considerable number of prairie dogs still remain in their towns. Controlled hunting would help to keep their population in check and avoid the need for poisoning. The rare black-footed ferret is seldom seen in prairie dog towns. Where he is present, he serves as a useful natural check on the population of prairie dogs.

The Valentine-Doger-Dunday association offers a wildlife habitat similar to that of the Valentine association. There are only a few subirrigated areas or wet spots. Some of these have willow and cottonwood trees in them. Patches of alfalfa are grown for supplemental livestock feed. This crop is also beneficial, however, as food for deer and antelope. Some fields of alfalfa are irrigated from wells.

Over the entire two-county area there are many kinds of birds. These include meadowlarks, lark buntings, mourning doves, kingbirds, magpies, and prairie horned larks. Pheasants are scarce because both grain and winter cover are quite limited.

Improvement of the wildlife habitat in Arthur and Grant Counties could be achieved by managing the rangelands properly. Planting windbreaks of adapted species (see section on windbreaks) would be beneficial for the protection of ranch headquarters in the winter as well as for the provision of winter cover for wildlife.

Zooplankton (microscopic animal life of a body of water) and phytoplankton (microscopic plant life produced in fertile ponds) provide food for larger aquatic animals such as frogs which, in turn, are used as food by fish.

Steep slopes and rough, irregular topography present hazards to livestock and are poorly suited for crop production. In these areas the natural undisturbed landscape can become escape cover for wildlife and provide a source of food.

In Arthur and Grant Counties the sandy texture of the soils presents a soil-blowing hazard unless the surface is maintained in permanent cover.

Wildlife habitat

The principal soil associations, as shown on the general soil map, are evaluated for wildlife habitat potential in Arthur and Grant Counties. Table 3 rates the potentials for each of the following habitat elements. The elements are described as follows:

Grain and seed crops consist of domestic grain or other seed-producing annuals planted to produce wildlife food. Examples are corn, sorghum, wheat, oats, barley, millet, soybeans, and sunflowers.

Domestic grasses and legumes consist of domestic perennial grasses and herbaceous legumes that are planted for wildlife cover and food. Examples are fescue, bluegrass, brome, timothy, orchardgrass, clover, alfalfa, trefoil, and crownvetch.

Wild herbaceous plants are native or naturally established dryland herbaceous grasses and forbs (including weeds) that provide food and cover for wildlife. Examples are bluestem, indiangrass, goldenrod, beggarticks, partridgepea, pokeweed, wheatgrass, fescue, and grama.

Hardwood trees and shrubs include nonconiferous trees and associated wood understory plants that provide wildlife cover or that produce nuts, buds, catkins, twigs, bark, or foliage used as food by wildlife. Shrubby plants are shrubs that produce buds, twigs, bark, or foliage used as food by wildlife or that provide cover and shade for some wildlife species. Examples are snowberry, honeysuckle, and Russian-olive.

Coniferous plants include cone-bearing trees, shrubs, or ground cover that furnish wildlife cover or supply food in the form of browse, seeds, or fruitlike cones. Commonly established through natural processes, they may be planted or transplanted. Examples are pine, spruce, fir, cedar, and juniper.

Wetland food and cover crops consists of annual and perennial wild herbaceous plants of moist to wet sites, exclusive of submerged or floating aquatics, that produce food or cover used extensively by wetland forms of wildlife. Examples are smartweed, wild millet, rushes, sedges, reeds, cordgrass, and cattail.

Shallow water areas are areas of surface water with an average depth of less than 5 feet, useful to wildlife. They may be natural wet areas or those created by dams or levees or by water-control devices in marshes or streams. Examples are muskrat marshes, waterfowl feeding areas, wildlife watering developments, wildlife ponds, and beaver ponds.

The kinds of wildlife habitat are open land, wetland, and rangeland. The soils are directly related to these three broad classes of wildlife.

Open-land wildlife: birds and mammals of croplands, pastures, meadows, lawns, and areas overgrown with grasses, herbs, shrubs, and vines. Examples are bobwhite quail, pheasant, meadowlark, killdeer, cottontail rabbit, red fox, and woodchuck.

Wetland wildlife: birds and mammals of swampy, marshy, or open-water areas. Examples are ducks, geese, herons, shore birds, rails, kingfishers, muskrat, mink, and beaver.

Rangeland wildlife: birds and mammals of natural rangelands. Examples are antelope, white-tailed deer, mule deer, prairie grouse, lark bunting, meadowlark, and prairie dog.

Table 3 also rates the soils according to their suitability for supporting various kinds of wildlife. The levels of suitability are expressed by an adjective rating as follows:

Good: Habitats are easily improved, maintained, or created. There are few or no soil limitations in habitat management and satisfactory results can be expected.

Fair: Habitats can be improved, maintained, or created on these soils, but moderate soil limitations affect habitat management or development. A moderate intensity of management and fairly frequent attention may be required to ensure satisfactory results.

Poor: Habitats can be improved, maintained, or created on these soils, but the soil limitations are severe. Habitat management may be difficult and expensive and require intensive effort. Results are questionable.

Very poor: Under the prevailing soil conditions, it is impractical to attempt to improve, maintain, or create habitats. Unsatisfactory results are probable.

Resources for recreation

The potential for recreation in Arthur and Grant Counties lies mainly in the historical significance of the Nebraska sandhills area and the possibility of establishing vacation ranches. Sunrises and sunsets in the sandhills are particularly beautiful, and wide panoramic views are the rule. Providing food and lodging for hunters during the seasons for hunting big game and grouse also has potential.

The fishing potential of the survey area is low because of the shallowness of the natural waters. Winterkills of fish often occur. There are a few farm ponds that provide limited fishing for large-mouthed black bass, bluegill, and bullhead. In Grant County five natural lakes (954 acres) have good potential for game fish, 20 lakes (1,221 acres) have fair potential, and 20 lakes (1,294 acres) are considered nonproductive.

TABLE 3.—*Potential of the principal soils in each soil association for wildlife habitat*

Soil association	Elements of wildlife habitat							Potential as habitat for—		
	Grain and seed crops	Domestic grasses and legumes	Wild herbaceous plants	Hardwood trees and shrubs	Coniferous plants	Wetland food and cover crops	Shallow-water areas	Open-land wildlife	Wetland wildlife	Rangeland wildlife
Valentine-Gannett-Elsmere:										
Valentine	Poor [1]	Fair [1]	Fair	Poor [1]	Poor [1]	Very poor	Very poor	Poor [1]	Very poor	Good [2].
Gannett	Very poor	Poor	Fair	Poor	Poor	Good	Good	Poor	Good	Fair.
Elsmere	Poor	Fair	Good	Fair [3]	Good	Good	Good	Fair	Good	Fair.
Valentine:										
Valentine	Poor [1]	Fair [1]	Fair	Poor [1]	Poor [1]	Very poor	Very poor	Poor [1]	Very poor	Good [2].
Valentine-Doger-Dunday:										
Valentine	Poor	Poor	Fair	Poor	Poor	Very poor	Very poor	Poor	Very poor	Good.
Doger	Fair	Fair	Good	Fair	Good	Very poor	Very poor	Fair	Very poor	Good.
Dunday	Fair	Fair	Good	Fair	Good	Very poor	Very poor	Fair	Very poor	Good.

[1] Very poor where slope is more than 17 percent.

[2] Fair where slope is more than 17 percent.

[3] Good for cottonwood and willow.

In Arthur County there are approximately 13 natural sandhills lakes having a combined area of about 2,970 acres. Of this total, 1,876 acres can be used for local fishing and 1,094 acres are nonproductive.

Developing good habitat for wildlife requires the proper location and distribution of vegetation. Technical assistance in planning wildlife developments and in determining which species of vegetation to use can be obtained at the local office of the Soil Conservation Service in Mullen or in Ogallala, Nebraska.

Additional information and assistance can be obtained from Nebraska Game and Parks Commission, the Bureau of Sport Fisheries and Wildlife, and from the Agricultural Extension Service.

The Soil Conservation Service also provides technical assistance in the planning and application of conservation practices for developing outdoor recreation facilities.

Engineering Uses of the Soils [6]

The purpose of this section is to help those who need information about using soils as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Some of the soil properties highly important in engineering are permeability, strength, compaction, drainage, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table and soil slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the soil on which they are built to predict performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 4, 5, and 6, which show, respectively, several estimated soil properties significant in engineering, interpretations for various engineering uses, and results of engineering laboratory tests on soil samples.

This information, along with the soil maps and other parts of this publication, can be used to make interpretations in addition to those given in tables 4 and 5. It can be used also to make other useful maps.

This information, however, is not intended for use in design, and it does not eliminate the need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 6 feet. Inspection of sites, especially small ones, is needed also because many delineated areas of a given soil mapping unit may contain small areas of other soils that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have special meaning in soil science but are not known to all engineers. The "Glossary" defines many of these terms commonly used in soil science.

Engineering classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified soil classification system (USCS) *(2)*, used by Soil Conservation Service engineers, U.S. Department of Defense, and others, and the American Association of State Highway and Transportation Officials system (AASHTO) *(1)*.

The Unified system is used to classify soils according to engineering uses for building material or for the support of structures other than highways. Soils are classified according to particle-size distribution, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes. There are eight classes of coarse-grained soils that are subdivided on the basis of gravel and sand content. These are identified as GW, GP, GM, GC, SW, SP, SM, and SC. Six classes of fine-grained soils are subdivided on the basis of the plasticity index. Nonplastic classes are ML, MH, OL, and OH; plastic classes are CL and CH. There is one class of highly organic soils, Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example CL–ML.

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system soil materials are placed in seven groups, ranging from A–1 through A–7, on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, which are the best soils for subgrade (foundation). At the other extreme, in group A–7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are divided as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The AASHTO classification for tested soils, with group index numbers in parentheses, is shown in table 6; the estimated classification, without group index numbers, is given in table 4 for all soils mapped in the survey area.

[6] ROBERT J. FREDRICKSON, civil engineer, Soil Conservation Service, helped prepare this section.

TABLE 4.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. to other series in this table. The

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification	
				Unified	AASHTO
	Feet	*Inches*			
*Doger:					
DdB, DdD	>5	0–60	Loamy fine sand	SM or SP-SM	A–2
For Dunday parts, see Dunday series.					
DfB	>5	0–33	Loamy fine sand	SM or SP-SM	A–2
For Dunday part, see Dunday series.		33–44	Fine sandy loam	SC, SM, or SM-SC	A–4 or A–6
		44–60	Fine sand	SP-SM or SP	A–3, A–2
Dunday:					
Mapped only with Doger soils.					
Dunday parts of DdB and DdD	>5	0–60	Loamy fine sand	SM or SP-SM	A–2
Dunday parts of DfB	>5	0–15	Loamy fine sand	SM or SP-SM	A–2
		15–36	Fine sandy loam	SC, SM, or SM-SC	A–4 or A–6
		36–60	Loamy fine sand	SM or SP-SM	A–2
Els:					
EcB	2–3	0–60	Fine sand	SM, SP, or SP-SM	A–3 or A–2
EdB	2–3	0–9	Loamy fine sand	SM or SP-SM	A–2
		9–40	Fine sand	SM, SP, or SP-SM	A–3 or A–2
		40–60	Fine sand	SM, SP, or SP-SM	A–3 or A–2
Elsmere: EfB	2–3	0–32	Loamy fine sand	SM or SP-SM	A–2
		32–60	Fine sand	SP-SM or SP	A–3 or A–2
*Gannett:					
Ga, Gb	(2)	0–9	Fine sandy loam	SC or SM	A–4 or A–6
For Loup parts, see Loup series.		9–25	Silt loam and fine sandy loam.	SC, SM, or ML	A–6 or A–4
		25–60	Fine sand	SP-SM, SP, or SM	A–3 or A–2
Gannett parts of Ld and Lf	(2)	0–25	Loamy fine sand	SM or SP-SM	A–2
		25–60	Fine sand	SP-SM, SP, or SM	A–3 or A–2
*Loup:					
Ld, Lf	(2)	0–11	Loamy fine sand	SM or SP-SM	A–2
		11–60	Fine sand and loamy fine sand.	SP or SP-SM	A–3, A–2
Loup parts of Ga and Gb	(2)	0–11	Fine sandy loam	SC or SM	A–4 or A–6
		11–60	Fine sand	SP or SP-SM	A–3 or A–2
Marsh: Ma. Too variable to be rated.					
Saline-Alkali land: Sa. Too variable to be rated.					
Tryon: Tk, Tn	(2)	0–5	Loamy fine sand	SM or SP-SM	A–2
		5–60	Fine sand	SP or SP-SM	A–3, A–2
Valentine: VaB, VaE, VaF, VaG	>5	0–60	Fine sand	SP or SP-SM	A–3, A–2

[1] Nonplastic.
[2] The water table ranges from 1 foot above the surface to 2 feet below the surface in the soils represented by mapping units Ga,

significant in engineering

These soils may have different properties and limitations; therefore, it is necessary to follow carefully the instructions for referring symbol > means more than]

Percentage less than 3 inches passing sieve— No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
					Inches per hour	*Inches per inch of soil*	*pH*	
	100	11–25	[1] NP	NP	6.0–20.0	0.08–0.12	6.6–7.8	Low.
	100	11–25	NP	NP	6.0–20.0	0.10–0.12	6.6–7.8	Low.
	100	36–50	25–40	6–17	2.0–6.0	0.14–0.16	6.6–7.8	Low.
100	95–100	3–12	NP	NP	6.0–20.0	0.05–0.07	6.6–7.8	Low.
	100	11–25	NP	NP	6.0–20.0	0.08–0.12	6.6–7.3	Low.
	100	11–25	NP	NP	6.0–20.0	0.10–0.12	6.6–7.3	Low.
	100	36–50	25–40	6–17	2.0–6.0	0.15–0.17	6.6–7.3	Low.
100	95–100	11–20	NP	NP	6.0–20.0	0.08–0.10	7.4–7.8	Low.
100	90–100	3–25	NP	NP	6.0–20.0	0.05–0.09	6.6–7.8	Low.
100	90–100	11–25	NP	NP	6.0–20.0	0.10–0.12	7.4–8.4	Low.
100	92–100	3–30	NP	NP	6.0–20.0	0.06–0.08	8.5–10.0	Low.
100	92–100	3–25	NP	NP	6.0–20.0	0.05–0.07	7.4–8.4	Low.
100	95–100	11–25	NP	NP	6.0–20.0	0.10–0.12	6.6–7.8	Low.
100	95–100	3–25	NP	NP	6.0–20.0	0.05–0.07	6.6–7.3	Low.
	100	36–50	30–40	8–18	2.0–6.0	0.16–0.18	7.3–8.4	Low.
	100	36–55	25–40	11–18	2.0–6.0	0.15–0.22	7.3–7.8	Low.
100	95–100	3–25	NP	NP	6.0–20.0	0.5–0.7	7.3–7.8	Low.
100	95–100	11–30	NP	NP	6.0–20.0	0.09–0.12	7.4–8.4	Low.
100	95–100	3–25	NP	NP	6.0–20.0	0.05–0.07	7.4–7.8	Low.
	100	11–25	NP	NP	6.0–20.0	0.10–0.12	6.6–8.4	Low.
100	95–100	2–25	NP	NP	6.0–20.0	0.05–0.08	7.4–8.4	Low.
	100	36–50	30–40	8–18	2.0–6.0	0.16–0.18	6.6–8.4	Low.
100	95–100	2–12	NP	NP	6.0–20.0	0.05–0.08	7.4–8.4	Low.
	80–95	11–25	NP	NP	6.0–20.0	0.10–0.12	7.3–7.8	Low.
100	90–100	2–12	NP	NP	6.0–20.0	0.05–0.08	6.6–7.8	Low.
	100	2–12	NP	NP	6.0–20.0	0.05–0.08	6.6–7.3	Low.

Ld, and Tk, and from 1 to 3 feet below the surface in the soils represented by mapping units Gb, Lf, and Tn.

TABLE 5.—*Interpretations of engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. ... to other series

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields [1]	Sewage lagoons	Shallow excavations	Dwellings with or without basements	Sanitary landfill [2]	Local roads and streets
*Doger: DdB, DdD, DfB. For Dunday parts, see Dunday series.	Slight	Severe: rapid permeability.	Severe: subject to caving where banks are not sloped.	Slight: subject to caving where banks are not sloped.	Severe: highly subject to soil blowing; rapid permeability; fair for cover soil.	Slight: subject to soil blowing.
Dunday. Mapped only with Doger soils.	Slight	Severe: rapid permeability.	Severe: subject to caving where banks are not sloped.	Slight: subject to caving where banks are not sloped.	Severe: highly subject to soil blowing; rapid permeability.	Slight: subject to soil blowing.
Els: EcB, EdB	Severe: seasonal high water table at depth of 2 to 3 feet.	Severe: rapid permeability; seasonal high water table at depth of 2 to 3 feet.	Severe: seasonal high water table at depth of 2 to 3 feet; subject to caving; coarse-textured soil material.	Severe: seasonal water table at depth of 2 to 3 feet; subject to caving and frost action.	Severe: seasonal high water table at depth of 2 to 3 feet; highly subject to soil blowing; rapid permeability; poor for cover soil.	Moderate: seasonal high water table at depth of 2 to 3 feet; highly subject to soil blowing; subject to frost action.
Elsmere: EfB	Severe: seasonal high water table at depth of 2 to 3 feet.	Severe: rapid permeability; seasonal high water table at depth of 2 to 3 feet.	Severe: seasonal high water table at depth of 2 to 3 feet; subject to caving; coarse-textured soil material.	Severe: seasonal high water table at depth of 2 to 3 feet; subject to frost action and caving.	Severe: seasonal high water table at depth of 2 to 3 feet; highly subject to soil blowing; poor for cover soil.	Moderate: seasonal high water table at depth of 2 to 3 feet; subject to soil blowing and frost action.
*Gannett: Ga, Gb. For Loup parts, see Loup series.	Severe: seasonal high water table; subject to flooding.	Severe: seasonal high water table; subject to flooding.	Severe: seasonal high water table; subject to caving and flooding.	Severe: seasonal high water table; subject to flooding.	Severe: seasonal high water table; rapid permeability below depth of 3 feet.	Severe: seasonal high water table; subject to frost action.
*Loup: Ld, Lf. For Gannett parts, see Gannett series.	Severe: seasonal high water table; subject to flooding.	Severe: seasonal high water table; subject to flooding.	Severe: seasonal high water table; subject to caving and flooding.	Severe: seasonal high water table; subject to caving and flooding.	Severe: seasonal high water table; rapid permeability.	Severe: seasonal high water table; subject to frost action.

properties of the soils

These soils may have different properties and limitations; therefore, it is necessary to follow carefully the instructions for referring in this table]

Suitability as source of—			Soil features affecting—			
Roadfill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation
Good: needs confinement; subject to soil blowing.	Fair below depth of 3 to 5 feet; limited uses because of gradation.	Poor: coarse-textured soil material.	Rapid permeability subject to soil blowing; requires sealing or lining.	Subject to soil blowing; good compaction characteristics; medium permeability of compacted soil.	Well drained; rapid permeability.	Rapid intake rate; low to moderate available water capacity; low natural fertility; subject to soil blowing.
Good: subject to soil blowing; needs confinement.	Fair below depth of 2 to 5 feet; limited uses because of gradation.	Poor: coarse-textured soil material.	Rapid permeability; subject to soil blowing; requires sealing or lining.	Subject to soil blowing; good compaction characteristics; medium permeability of compacted soil.	Well drained; rapid permeability.	Rapid intake rate; low to moderate available water capacity; low natural fertility.
Poor: seasonal high water table at depth of 2 to 3 feet; borrow areas need draining; needs confinement; subject to frost action.	Fair below depth of 1 foot; limited uses because of gradation; needs draining to excavate.	Poor: coarse texture; subject to soil blowing.	Rapid permeability; water table from depth of 2 feet in spring to 5 feet early in fall.	Subject to soil blowing; good compaction characteristics; borrow areas may be below water table; medium to high permeability of compacted soil.	Outlets limited; depth to water table from 2 feet in spring to 5 feet early in fall.	Rapid intake rate; low available water capacity; subject to soil blowing; water table at depth of 2 feet in spring to 5 feet early in fall.
Poor: seasonal high water table at depth of 2 to 3 feet; subject to soil blowing and frost action.	Fair below depth of 2 feet; limited uses because of gradation; needs draining.	Poor: coarse texture; subject to soil blowing.	Rapid permeability; water table from depth of 2 feet early in spring to 5 feet early in fall.	Subject to soil blowing; good compaction characteristics; medium permeability of compacted soil.	Outlets limited; depth to water table from 2 feet in spring to 5 feet in fall; rapid permeability.	Rapid intake rate; moderately low available water capacity; subject to soil blowing; water table at depth of 2 feet in spring to 5 feet in fall.
Poor: seasonal high water table; needs draining.	Fair below depth of 4 feet; needs draining; limited uses because of gradation.	Poor: seasonal high water table.	High water table; moderately rapid permeability.	Good compaction characteristics; subject to soil blowing; low to medium permeability of compacted soil.	Outlets limited; water table; rapid permeability below depth of 3 feet.	Not suited; high water table.
Poor: seasonal high water table; needs draining.	Fair below depth of 2 feet; needs draining; limited uses becauses of gradation.	Poor: seasonal high water table.	High water table; rapid permeability.	Medium to high permeability for compacted soil; good compaction characteristics.	Outlets limited; rapid permeability; high water table.	Not suited; high water table.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields [1]	Sewage lagoons	Shallow excavations	Dwellings with or without basements	Sanitary landfill [2]	Local roads and streets
Marsh: Ma. Too variable to be rated. Severe limitations for most uses because of very high seasonal water table.						
Saline-Alkali land: Sa. Too variable to be rated. Severe limitations for most uses because of saline-alkali soil condition.						
Tryon: Tk, Tn	Severe: seasonal high water table; flooding.	Severe: seasonal high water table; flooding.	Severe: seasonal high water table; flooding.	Severe: seasonal high water table; flooding; subject to caving.	Severe: seasonal high water table; subject to soil blowing; rapid permeability; poor cover soil.[1]	Severe: seasonal high water table; subject to soil blowing and frost action.
Valentine: VaB, VaE, VaF, VaG.	Slight if slope is less than 8 percent, moderate if 8 to 15 percent, severe if more than 15 percent.	Severe: rapid permeability; severe also if slope is more than 15 percent.	Severe: subject to caving; coarse-textured soil; severe also if slope is more than 15 percent.	Slight if slope is less than 8 percent, moderate if 8 to 15 percent, severe if more than 15 percent, subject to caving.	Severe: rapid permeability; some areas have very steep slopes; poor for cover soil; subject to soil blowing.[1]	Slight if slope is less than 8 percent, moderate if 8 to 15 percent, severe if more than 15 percent; subject to soil blowing.

[1] Pollution may be hazardous to water supplies.
[2] Onsite studies of the underlying strata, the water table, and the hazards of aquifer pollution and drainage into ground water

USDA texture is determined by the relative proportions of sand, silt, and clay in soil material that is less than 2.0 millimeters in diameter. Sand and silt, among the terms used in the USDA textural classification, are defined in the "Glossary." Stones, cobbles, and gravel are used as textural modifiers where present in the soil.

Soil properties significant in engineering

Several estimated soil properties significant in engineering are given in table 4. These estimates are based on the observation that layers of representative soil profiles have significantly different soil properties. The estimates are prepared by means of field observations made in the course of mapping, test data for these and similar soils, and experience with the same kinds of soil in other counties. (Bedrock is deeper than 5 feet for all soils in Arthur and Grant Counties.) In the following paragraphs are explanations of some of the columns in table 4.

Depth to seasonal high water table is the distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

Soil texture is described in table 4 in standard terms *properties of the soils*—Continued

Suitability as source of—			Soil features affecting—			
Roadfill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation
Poor: seasonal high water table; needs draining.	Fair below depth of 1 foot; poor gradation of sand sizes; needs draining.	Poor: coarse soil texture; seasonal high water table.	High water table; rapid permeability.	Low compressibility; high permeability of compacted soil; subject to soil blowing; good compaction characteristics.	Outlets limited; rapid permeability; high water table.	Not suited; high water table.
Good if slope is less than 15 percent, fair if 15 to 25 percent, poor if more than 25 percent; subject to soil blowing if exposed; needs confinement.	Fair below depth of 1 foot; limited uses because of gradation.	Poor: coarse-textured soil; slopes more than 15 percent in some areas.	High seepage because of rapid permeability.	Subject to soil blowing; good compaction characteristics; coarse-textured soil, difficult to vegetate; high permeability of compacted soil.	Excessively drained; rapid permeability.	Rapid intake rate; low water capacity; highly subject to soil blowing; generally not suited if slope is more than 6 percent; coarse-textured soil.

are needed in landfills more than 5 or 6 feet deep.

used by the U.S. Department of Agriculture. These terms are based on the percentages of sand, silt, and clay in the proportion of the soil that is less than 2 millimeters in diameter. Loam, for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added; for example, gravelly loamy sand. The terms sand, silt, clay, and some of the other terms used in USDA textural classification are defined in the "Glossary" of this soil survey.

Tests for plastic limit and liquid limit measure the effect of water on the consistence of the soil material. As the moisture content of a clayey soil increases from a dry condition, the soil changes from a solid to a plastic state and then to a liquid state. The *plastic limit* is the moisture content, expressed as a percentage of the oven-dry weight, at which the soil passes from a solid to a plastic state. The *liquid limit* is the moisture content at which the soil passes from a plastic to a liquid state. The *plasticity index* is the numerical difference in percentage of moisture between the plastic limit and the liquid limit. It indicates the range of moisture content within which a soil material is

TABLE 6.—*Engineering*

Tests performed by the Nebraska Department of Roads in accordance with standard procedures

Soil name and location	Parent material	Report No. S70—	Depth	Specific gravity[1]	Mechanical analysis[2] Percentage passing sieve— No. 10 (2.0 mm)	No. 40 (0.42 mm)
			Inches			
Dunday loamy fine sand: 0.25 mile E. and 0.1 mile S. of center of sec. 35, T. 22 N., R. 39 W. (Modal)	Eolian sand.	1640	0–19	2.59	------------	100
		1641	25–42	2.63	------------	100
Els fine sand: 0.25 mile E. and 0.12 mile N. of center of sec. 6, T. 22 N., R. 38 W. (Modal)	Eolian sand.	1636	0–6	2.60	100	92
		1637	11–40	2.63	100	99
Elsmere loamy fine sand: 0.25 mile S. and 0.2 mile W. of NE. corner of sec. 11, T. 12 N., R. 39 W. (Modal)	Eolian sand.	1638	0–16	2.58	100	99
		1639	22–40	2.65	100	99
Gannett fine sandy loam: 0.25 mile N. of SE. corner of sec. 26 T. 24 N., R. 38 W (Modal)	Eolian sand.	1627	0–9	2.43	------------	100
		1628	9–14	2.57	------------	100
		1629	16–25	2.48	------------	------------
		1630	25–29	2.60	------------	100
		1631	29–40	2.60	------------	100
Loup loamy fine sand: 0.3 mile W. of center of sec. 22, T. 24 N., R. 36 W. (Modal)	Eolian sand.	1634	0–5	2.56	------------	100
		1635	11–29	2.64	------------	100

[1] Specific gravity based on standard procedure, AASHTO Designation T 100–70 (*1*).

[2] Mechanical analyses according to the American Association of State Highway and Transportation Officials Designation T 88–47 (*1*). Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method and the various grain-sized fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-sized fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soil.

considered to be plastic. Some silty and sandy soils are nonplastic, which means that they do not become plastic at any moisture content.

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly structure, porosity, and texture. Lateral seepage and such transient soil features as plowpans and surface crusts are not considered.

Available water capacity is the ability of soils to hold water for use by most plants. It is defined here as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most plants.

Reaction refers to the acidity or alkalinity of a soil, expressed in pH values for a stated soil-solution mixture. The pH value and terms used to describe soil reaction are explained in the "Glossary."

Shrink-swell potential refers to the relative change in volume to be expected of soil material with changes in moisture content, that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. The extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils may damage building foundations, roads, and other structures. Soils having a high shrink-swell potential are the most hazardous.

Shrink-swell potential is not indicated for organic soils or certain soils that shrink markedly on drying but do not swell quickly when rewetted. None of the soils in Arthur and Grant Counties has a significant potential for shrinking or swelling.

Engineering interpretations

The estimated interpretations in table 5 are based on the engineering properties of the soils shown in table 4, on test data for the soils in this survey area and others nearby, and on the experience of engineers and soil scientists with the soils of Arthur and Grant Counties. In table 5, the ratings of *slight, moderate,* or *severe* are used to summarize the limitations of soils for use as septic tank absorption fields, sewage lagoons, shallow excavations, foundations for dwellings with or without basements, sanitary landfill, and local streets and roads. The ratings *good, fair,* and *poor* are *test data*

of the American Association of State Highway and Transportation Officials (AASHTO) (*1*)]

Mechanical analysis [2]—Continued						Liquid limit	Plasticity index	Classification	
Percentage passing sieve—		Percentage smaller than—							
No. 60 (0.25 mm)	No. 200 (0.074 mm)	0.05 mm	0.02 mm	0.005 mm	0.002 mm			AASHTO [3]	Unified [4]
99	16	11	8	4	3	[5] NP	NP	A-2-4(0)	SM
99	12	8	7	4	2	NP	NP	A-2-4(0)	SP-SM
80	16	10	8	4	3	NP	NP	A-2-4(0)	SM
98	23	13	9	7	6	NP	NP	A-2-4(0)	SM
94	15	10	7	4	3	NP	NP	A-2-4(0)	SM
92	12	8	6	3	3	NP	NP	A-2-4(0)	SP-SM
94	39	36	28	22	15	38	17	A-6(3)	SC
99	49	41	35	26	19	33	14	A-6(4)	SC
100	50	40	36	21	15	35	11	A-6(3)	SC
99	15	10	8	3	2	NP	NP	A-2-4(0)	SM
99	15	7	6	2	1	NP	NP	A-2-4(0)	SM
94	21	16	15	7	5	NP	NP	A-2-4(0)	SM
92	6	4	3	1	1	NP	NP	A-3(0)	SP-SM

[3] Based on Standard Specifications for Highway Material and Methods of Sampling and Testing (Pt. 1, Ed. 8). The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes, AASHTO Designation M 145-40 (*1*).

[4] Based on the Unified Soil Classification System (*2*).

[5] Nonplastic.

used in table 5 to evaluate the suitability of the soils for use as roadfill, sand, and topsoil. Also given in the table are the soil features that affect pond reservoir areas; embankments, dikes, and levees; drainage of cropland and pasture; and irrigation. The table is a guide to planning, installation, and maintenance. It cannot, however, replace onsite investigation of specific tracts of land.

In the soil limitation ratings, *slight* means that the soil properties are generally favorable for the rated use, or in other words, that limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means that the soil properties are so unfavorable and so difficult to correct or overcome that they require major soil reclamation, special designs, or intensive maintenance. For some uses, the rating of severe is divided to obtain ratings of severe and very severe.

Soil suitability is rated by the terms *good, fair,* and *poor,* which have, respectively, meanings that are approximately parallel to those for the terms slight, moderate, and severe.

The following are explanations of some of the terms in table 5:

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 6 feet is evaluated. The soil properties considered are those that affect the absorption of effluent as well as the construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope is a soil property that affects the difficulty of layout and construction, the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor and sides, or embankments, of compacted soil material. The embankments are compacted to a medium density to protect against seepage. In addition, the pond is protected from flooding. Properties that affect the pond floor are permeability, content of organic matter, and slope. If the floor needs to be leveled, depth to bedrock becomes important also. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified soil classification system and the amounts of stones, if any, that influence the ease of excavation and the compaction of the embankment material.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet; for example, excavations for pipelines, sewer lines, phone and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or big stones, and freedom from flooding or a high water table.

Dwellings, as rated in table 5, are not more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to the capacity to support load and to resist settlement under load and those that relate to ease of excavation. Soil properties that affect the capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Sanitary landfill is refuse that has been disposed of in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 5 apply only to a depth of about 6 feet, and therefore limitation ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than than. For some soils, reliable predictions can be made to a depth of 10 or 15 feet; but regardless of that. every site should be investigated before it is selected.

Local roads and streets, as rated in table 5, have an all-weather surface expected to carry automobile traffic all year long. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of roads and streets are load-supporting capacity and stability of the subgrade and the workability and quantity of cut and fill material available. The AASHTO and Unified classification of the soil material, and also the shrink-swell potential, indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Road fill is soil material used in embankments for roads. The suitability ratings reflect (1) the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and (2) the relative ease of excavating the material at borrow areas.

Sand is used in great quantities in many kinds of construction. The ratings in table 5 provide guidance about where to look for probable sources. A soil rated as a *good* or *fair* source of sand generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect the mining of the materials, and they do not indicate the quality of the deposit.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material, as in preparing a seedbed; by the natural fertility of the material, or the response of plants when fertilizer is applied; and by the absence of substances toxic to plants. Texture of the soil material and its content of stone fragments are characteristics that affect suitability, but considered also in the ratings is any damage expected to result in the area from which topsoil is taken.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured bedrock or other permeable material.

Embankments, dikes, and levees. require soil material that is resistant to seepage and piping and that has favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material in a soil are among factors that are unfavorable.

Drainage of cropland and pasture is affected by soil properties such as permeability, texture, and structure; depth to claypan, rock, or other layers that influence the rate of water movement; depth to the water table; steepness of slope and stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation of a soil is affected by features such as steepness of slope; susceptibility to stream overflow, water erosion, or soil blowing; texture; content of stones; accumulations of salts and alkali; depth of root zone; rate of water intake at the surface; permeability of soil layers below the surface layer and of other layers that restrict movement of water; amount of water held available to plants; and need for drainage or depth to water table or bedrock.[7]

Engineering test data

Table 6 contains engineering test data for some of the major soil series in Arthur and Grant Counties. The purpose of the tests was to help in the evaluation of the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Tests to determine liquid limit and plastic limit mea-

[7] Further information on soil use for irrigation is contained in the Irrigation Guide for Nebraska: United States Department of Agriculture, Soil Conservation Service, Lincoln Nebraska. (1971)

sure the effect of water on the consistence of soil material.

Specific gravity is the ratio of the unit weight of the soil solids to the unit weight of water. It is a measure of the heaviness of soil. The specific gravity of the solid particles of a soil, exclusive of the void spaces, is also called the true, or real, specific gravity. This property has an important influence on the density of the soil.

Formation and Classification of the Soils

This section consists of two major parts. The first tells how the factors of soil formation have affected the development of soils in Arthur and Grant Counties. The second explains the system of soil classification currently used and classifies each soil series according to that system.

Factors of Soil Formation

Soil is produced by soil-forming processes acting on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, the lay of the land, and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil profile. It may be much or little, but some time is always required for differentiation of soil horizons. Usually, a long time is always required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent material

The soils of Arthur and Grant Counties have developed primarily in eolian sediments of sand size. The sand is of mixed mineralogy, with quartz and feldspars being the principal minerals. A typical particle-size distribution is clay, 2 to 5 percent; silt, 1 to 4 percent; very fine sand, 18 to 25 percent; fine sand, 55 to 70 percent; medium and coarse sand, 12 to 20 percent.

Wind action has winnowed and shifted the sands to form rolling and hilly dunes (*3*). These consist mainly of Valentine soils. The parent material of the soils in the swales and valleys between the ranges of sandhills contains slightly more silt and clay than is typical for the hills and dunes. These are mainly the Doger and Dunday soils in dry valleys and the Elsmere, Els, Loup, and Tryon soils in the wet valleys. There are no valleys with recent alluvial fills in the survey area. There are only a few miles of perennial streams in the area, and near these there is only slight evidence of alluvial deposition.

Climate

Arthur and Grant Counties have a subhumid climate characterized by extremes of temperature and moisture distribution. Annual precipitation averages 18.4 inches, but it ranges from about 10 to 30 inches a year. Most of the rainfall comes during the growing season, but much of it is lost by deep percolation through the soil. Heavy or light rains break the frequent, sometimes extended, drought periods in the area and wet the dry soil profile. The alternate wetting and drying of the soil results in wide fluctuations in biologic, especially microbiologic, activity. Rainfall is adequate to maintain a good grass cover and to leach free lime from all well-drained and excessively drained soils. Climate is fairly uniform throughout the survey area, and major differences in soil are not due to differences in climate.

Plant and animal life

Vegetation has been important in the formation of the soils in Arthur and Grant Counties. Vegetation stabilized the shifting sands long enough for soils to develop. It provided the organic matter that is an important indicator of soil development. Organic matter produced the dark color in the surface layer of the soil. Gannett soils have the highest amount of organic matter of any soil in the survey area. Valentine, Tryon, and Els are low in organic-matter content. The vegetation is composed mainly of grasses mixed with a few forbs and small shrubs (*3*). Tall sedges and rushes are dominant on poorly drained soils. Few native trees grow in the area. The soils in Arthur and Grant Counties are typical of grassland areas.

The numbers and kinds of living organisms are important in soil development. Micro-organisms use the undecomposed organic matter in the soil as food and change it into humus. Some kinds of bacteria take nitrogen from the air that aids in their growth. When these bacteria die, the nitrogen can be used by plants. Rodents, mice, and other forms of animal life that live in the soil are common, but earthworms are not common in either the excessively drained or the poorly drained soils of the survey area.

Man's activity also affects the formation of soils. By the kind of management he uses, man determines the kinds and amounts of vegetation returned to the soil and whether the soil is conserved or lost through erosion.

Relief

The crests of the dunes in the choppy landscape of Arthur and Grant Counties are about 200 to 400 feet above the floor of the adjacent valleys. The slope is generally in the range of 17 to 60 percent, but in small areas it is even steeper. Development of soils is slow in these areas because erosion is very severe on the slopes. Soil blowing and water erosion combine to prevent much development. A small amount of runoff occurs even though the soils are coarse textured. The light-colored fine sand of the parent material is exposed in many places on these very steep slopes. Where there is soil development, the surface layer is thin and only slightly darkened by organic matter. There is seldom a well defined AC horizon. The soils in these areas are in the Valentine series.

The rolling landscape of the county has a slope of about 3 to 17 percent and soil development in such localities is correspondingly greater than in the choppy landscape. The surface layer is slightly thicker and slightly darker colored, and the AC horizon is generally well defined. Nearly all the rainfall in these areas enters the coarse-textured soils. Valentine soils are typical in these areas, although soils in the Doger and Dunday series are found in a few places.

In the dry valleys relief ranges from 1 foot to about 10 feet, and slope ranges from 1 to 9 percent. Relief is generally highest where the valleys merge with the adjacent sandhills. The surface layer and transition layer are generally thicker than where the slope and relief are higher. The surface layer is usually 10 to 20 inches thick, but it may be as thick as 30 inches. The content of the organic matter is also higher in these areas than in soils of the hilly and rolling landscapes.

The wet valleys have the lowest relief. It ranges from 1 to 3 or 4 feet from the surface of Marsh and lakes to the highest elevations of the adjacent soils. Most of these areas have a thick surface layer that is dark colored and that has a moderate organic-matter content. Occurring in these areas are the Elsmere, Gannett, and Loup soils. A smaller percentage of the soils in wet valleys are young and thus are not so strongly developed. These are the Els and Tryon soils.

Time

The soils of Arthur and Grant Counties range from intermediate to very young. There are no relatively old soils in the survey area as compared to mature soils of areas further east. The soils of this survey are different, however, not only in actual years of age but also in apparent age. These differences in actual and apparent age are shown by the degree of profile development. This is indicated primarily by the thickness and color of the surface layer. Valentine fine sand, hilly, is a young soil. It has had time to develop only a thin surface layer and has little structure. Valentine fine sand, rolling, is slightly older because it has been in place long enough for a thicker surface layer to develop. Doger and Dunday soils, which have a thick surface layer and more definite structure, are older than Valentine soils. In the wet valleys that have a high water table, Els and Tryon soils are the youngest, Loup and Elsmere soils are of intermediate age, and Gannett soils are oldest.

The length of time it takes for a soil to develop to maturity depends on the interrelationships of the other soil-forming factors. The parent material for nearly all the soils in Arthur and Grant Counties is loose sand. Thus, soil development, other than the accumulation of organic matter in the surface layer, proceeds slowly.

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Because this system is under continual study, readers interested in developments of the current system should search the latest literature available (*4, 6*).

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are groups. The same property or subdivisions of this property may be used in several different categories. The soil series of Arthur and Grant Counties were placed in three categories of the current system in table 7 in May 1974. Classes of the current system are briefly defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The prop-

TABLE 7.—*Soil series classified according to the current system*

Series	Family	Subgroup	Order
Doger	Sandy, mixed, mesic	Entic Haplustolls	Mollisols.
Dunday	Sandy, mixed, mesic	Entic Haplustolls	Mollisols.
Els	Mixed, mesic	Aquic Ustipsamments	Entisols.
Elsmere	Sandy, mixed, mesic	Aquic Haplustolls	Mollisols.
Gannett	Coarse-loamy, mixed, mesic	Typic Haplaquolls	Mollisols.
Loup	Sandy, mixed, mesic	Typic Haplaquolls	Mollisols.
Tryon	Mixed, mesic	Typic Psammaquents	Entisols.
Valentine	Mixed, mesic	Typic Ustipsamments	Entisols.

erties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. Three exceptions to this are the Entisols, Histosols, and Vertisols, which occur in many different climates.

SUBORDER. Each order is subdivided into suborders using those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders are more narrowly defined than are the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of a water table at a shallow depth; soil climate; the accumulation of clay, iron, or organic carbon in the upper solum; cracking of soils caused by a decrease in soil moisture; and fine stratification.

GREAT GROUP. Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of soil horizons and features. The horizons used to make separations are those in which clay, carbonates, and other constituents have accumulated or have been removed; and those that have pans that interfere with growth of roots, movement of water, or both. Some features used are soil acidity, soil climate, soil composition, and soil color.

SUBGROUP. Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and others called intergrades that have properties of the group and also one or more properties of another great group, suborder, or order.

FAMILY. Soil families are separated within a subgroup primarily on the basis of properties important to the growth of plants or to the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, soil depth, and consistence.

Physical and Chemical Analyses

A profile of a Valentine soil from Arthur County was analyzed in the Soil Survey Laboratory to determine its physical and chemical properties. The data are published in Soil Survey Investigations Report No. 5 (*7*). The data are useful to soil scientists in classifying soils and in developing concepts of how the soils form. They are also helpful in estimating permeability, available water capacity, fertility, and other properties that affect soil management.

Environmental Factors Affecting Soil Use

This section provides general information about the geology, relief, and drainage of the survey area. It also gives facts about the water supply, vegetation, climate, transportation facilities, markets, and trends in soil use. Statistics used are mainly from the U.S. Bureau of the Census and the State-Federal Division of Agricultural Statistics in Lincoln, Nebraska.

Geology, Relief, and Drainage

The soils of Grant and Arthur Counties formed in sands of eolian origin which mantle older Pleistocene silty sands and marly siltstone. The older Pleistocene deposits are not exposed in the survey area but are exposed in adjoining Hooker and McPherson Counties. In most of the survey area the surface of the older Pleistocene deposits is below the elevation of the valley floors. The bedrock, Ogallala sandstone, is below the Pleistocene deposits, and it crops out in adjoining Keith County but not in Grant or Arthur Counties.

The unconsolidated sands have been transported and sorted by the wind and blown into sand dunes, forming a topography resembling ripples on a stream bottom. Individual sand dunes have commonly coalesced to form sand dune ridges, which generally trend east-northeast and west-southwest. The dunes and dune ridges range from ½ to 7 miles in length and up to 1 mile in width. Some rise from 200 feet up to almost 400 feet above the interdune valley floors. Their slopes are usually steepest on the south and southeast sides. In a few valleys the occurrence of silt loam and clay loam in soil profiles suggests that the valley may have cut into Pleistocene silt.

Valleys between the ridges are generally not as wide as the dune ridges but are similar in length and orientation. Valley floors range from nearly level to rolling. The lowest parts of many valleys extend to the water table and are occupied by lakes. The lakes are surrounded by concentric bands of Marsh, poorly drained soils, and somewhat poorly drained soils. The wetness of the soil decreases as the depth to the water table increases.

Most of Grant and Arthur Counties is well drained to excessively drained. Drainage is mainly by percolation through the porous soil to the water table. The water table is above the surface of the earth in many valleys where lakes and marshes are formed. The water level in some valleys is controlled by drainage installations. Open ditches are installed to collect water and move it to a lower valley or to a pump and pipeline that conducts the water to the disposal area. The drainage systems are designed to remove surface water from the area. Their influence on water in the soil profile is usually minor. Most drainage projects end in enclosed valleys. A few in the northern part of Grant County drain into the South Branch of the Middle Loup River, and a few in the southeastern part of Grant County drain into the North Fork of the Dismal River.

Water Supply

Arthur and Grant Counties have an abundant supply of water. This entire area is underlain with deep beds of saturated material that is mainly sand. Nearly all this material yields adequate water to supply wells. Deeper aquifers generally yield soft water of excellent quality. The higher aquifers generally yield hard water high in minerals.

Water for domestic purposes and most water for livestock and irrigation comes from wells. Most wells range from 40 to 150 feet in depth. Lakes and streams supplement the water for livestock and, in a few places, for irrigation. In many places flowing wells provide water for livestock.

There are about 9,350 acres of lakes and Marsh in Grant County and 3,550 acres in Arthur County. These are used mainly as habitat for wildlife.

TABLE 8.—*Temperature and precipitation*

[Data in all but the last two columns are from Arthur, Arthur County, Nebraska. Data in the last two columns are from Mullen, Hooker County, Nebraska. Period of record 1941-70]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Average monthly maximum	Average monthly minimum	Average total	One year in ten will have— Equal to or less than—	One year in ten will have— Equal to or more than—	Days with 1 inch or more snow cover	Average depth of snow on days with snow cover
	°F	°F	°F	°F	Inches	Inches	Inches	Number	Inches
January	37	10	57	-16	0.3	([1])	0.7	9	4
February	42	14	61	-9	.3	.1	.8	10	4
March	48	19	72	-4	.6	.1	1.2	8	4
April	62	32	82	14	1.6	.3	2.9	2	4
May	71	43	89	26	3.2	1.4	5.8	([2])	5
June	80	52	95	39	3.6	1.4	5.9	----------	----------
July	88	58	99	46	3.3	1.1	5.9	----------	----------
August	86	57	98	44	2.1	.7	3.7	----------	----------
September	77	46	92	29	1.7	.2	3.4	([2])	2
October	66	34	84	17	1.0	.2	2.3	([2])	4
November	50	21	70	2	.4	.1	.9	2	3
December	40	13	61	-10	.3	.1	.6	9	3
Year	62	33	[3] 101	[4] -20	18.4	13.5	23.2	40	4

[1] Trace.

[2] Less than half a day.

[3] Average annual highest temperature.

[4] Average annual lowest temperature.

Climate [8]

Arthur and Grant Counties have a continental climate characterized by frequent and rapid weather changes throughout the year. The annual precipitation fluctuates between that of the humid and arid regions. Summers are warm, and winters are rather cold despite periodic intrusions of warm downslope winds.

Precipitation that falls during autumn, winter, and early in spring is generally well distributed and accumulates at a slow rate. Showers and thunderstorms are the main source of precipitation during the remainder of the year. Hail is reported on an average of four times a year. A severe hailstorm usually occurs once a year somewhere in the two-county area. Tornadoes are infrequent.

Approximately 84 percent of the average annual precipitation falls during the warm half of the year, April through September (table 8). In the course of an average year, 80 days receive 0.01 inch or more precipitation while 40 days have 0.10 inch or more. Precipitation amounting to 0.50 inch or more occurs on an average of 11 days each year; 10 of these are in the warm half of the year when the potential for soil erosion is high. To be expected once a year is rainfall equalling or exceeding 0.8 inch in 30 minutes, 1.0 inch in an hour, 1.2 inches in 3 hours, 1.6 inches in 12 hours, and 1.7 inches in 24 hours. A daily rainfall of 2.2 inches or more usually happens once every two years; a 24-hour amount of 4.1 inches or greater normally occurs once in 25 years.

Average annual snowfall adds up to about 29 inches and accounts for approximately 16 percent of the annual precipitation. Snow does not remain on the ground for extended periods except during severe winters. Snowfalls are often accompanied by strong north winds. Blizzard conditions result at times.

Irrigation is necessary for growing some crops since sufficient moisture is not normally provided by the annual precipitation. The chances of receiving a weekly rainfall of 1 inch or more are 40 percent early in June but only 20 percent late in July and August.

Recorded temperature extremes are from 113° F at Arthur on July 25, 1936, to –34° F at Hyannis on January 17, 1930. Days with temperatures of 90° F or higher average 37 each year. However, since these temperatures are often accompanied by low relative humidities, undue heat stress to livestock is avoided. Freezing temperatures occur on an average of 175 days each year. The freeze-free season normally lasts 135 days. The probabilities of freezing temperatures are shown in table 9.

Annual evaporation from small lakes and ponds averages 65 inches. Approximately 76 percent of this occurs between May 1 and October 31.

[8] By MORRIS S. WEBB, JR., climatologist for Nebraska, National Weather Service, U.S. Department of Commerce.

Natural Vegetation

The principal natural resources of Arthur and Grant Counties are grass and water. Practically all the two-county area is covered with native grass that is

TABLE 9.—*Probabilities of last freezing temperatures in spring and first in fall*

[Data from Hyannis, Grant County, Nebraska. Period of record 1921-70]

Probability	Dates for given probability and temperatures [1]				
	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
One year in ten later than—	April 19	April 28	May 8	May 17	May 29
Two years in ten later than—	April 14	April 23	May 2	May 12	May 24
Five years in ten later than—	April 4	April 13	April 22	May 3	May 13
Fall:					
One year in ten earlier than—	October 22	October 13	October 3	September 22	September 10
Two years in ten earlier than—	October 27	October 19	October 8	September 27	September 15
Five years in ten earlier than—	November 7	October 28	October 18	October 7	September 25

[1] All freeze data are based on temperatures measured in a standard National Weather Service thermometer shelter. The thermometers are placed approximately 5 feet above the ground at an exposure believed representative of the surrounding area. Lower temperatures will exist at times nearer the ground and in local areas subject to extreme air drainage on calm nights.

used for feeding livestock. The large areas in grass are used either as hayland or rangeland. Upland vegetation—dominated by prairie sandreed, sand bluestem, little bluestem, and switchgrass—is used mainly as rangeland. Subirrigated and wet valleys have vegetation dominated by big bluestem, switchgrass, indiangrass, prairie cordgrass, and members of the sedge family. The wet valleys are used mainly as hayland.

Transportation and Markets

The only railroad transportation in the survey area is provided by a line of the Burlington Northern, Inc., that runs from Lincoln to Alliance and passes through the northern part of the area. Paralleling the railroad is hard-surface State Highway 2. State Highway 61 crosses the area from north to south near its middle. State Highway 92 coincides with 61 in the southern part of the survey area and runs eastward from the town of Arthur. Various branches of one-lane county roads, blacktop or gravel, serve all the ranch headquarters in Arthur County and many in Grant County. Several ranch headquarters in Grant County can be reached only by traveling for several miles on unimproved roads. Public airports at Arthur and Hyannis and several private airports provide services for small aircraft.

Most supplies are delivered to the survey area and most livestock is moved to market by truck. Omaha, Sioux City, Kansas City, and Denver are the most commonly used markets. A few cattle are sold at auctions in Thedford to the east, in Alliance to the west, and in Oshkosh and Ogallala to the south.

Trends in Soil Use

The farm economy of Arthur and Grant Counties is based almost entirely on the raising of beef cattle. Over 95 percent of the land in these counties is in grass and alfalfa. It is used principally for hay, pasture, and range. The rest of the land is devoted to roads, railroads, towns, ranch headquarters, airports, and other farm uses.

Many settlers found that they were unable to make an adequate living on the 640 acres provided them by the Kincaid act. Many sold out to their neighbors. As individual ownerships increased in size, the population and the extent of cultivation decreased.

Ranchers started to develop irrigation in the survey area during the 1950's. In 1962 there were seven wells irrigating 800 acres in Arthur County and two wells irrigating 500 acres in Grant County. Ten years later, in 1972, there were 23 registered wells in Arthur County irrigating 3,300 acres and five registered wells in Grant County irrigating 600 acres. Some of the wells originally registered are no longer used. Most of the irrigated soil in Arthur and Grant Counties, which is in alfalfa and tame grasses, is used for hay and pasture.

Other than alfalfa, the acreage of cultivated crops is very small. No corn was grown during 1962 in the survey area. Two hundred acres of corn were grown for feed in 1973 in Arthur County. In 1962 there were 1,280 acres of rye grown in Arthur County, but only 200 acres of rye were grown in 1972. In 1962 no sorghum was grown, but in 1972 there were 110 acres of sorghum grown in Arthur County.

Alfalfa is the most stable of the cultivated crops in the survey area. In 1962 there were 9,000 acres of this crop in Arthur County and no acres in Grant County. In 1972 this increased to 11,600 acres in Arthur County and to 300 acres in Grant County. In Arthur County 170 acres of alfalfa were harvested for seed in 1972. Tame hay was grown in 1972 on 3,800 acres in Arthur County and on 500 acres in Grant County.

In 1962 there were 300 sheep in the survey area, but in 1972 that number had decreased to only 200 head. In 1962 there were 430 hogs in the survey area, but that total increased to 1,000 head by 1972. Chickens are kept by ranchers and residents of the small towns. These totaled 3,380 in 1962 and 1,580 in 1972. There were 410 milk cows in the survey area during 1962; by 1972 that figure had decreased to 190.

Raising beef cattle is the stable enterprise in the survey area. In 1962 there were 32,270 head in Arthur County and 57,730 head in Grant County. By 1972 these totals increased to 37,019 head in Arthur County and 61,900 in Grant County.

From 1962 to 1972 the acres of wild hay in Arthur County declined from 67,260 acres to 58,000 acres. In Grant County wild hay declined from 70,320 acres to 57,000 acres during that period.

The number of farms in Arthur County in 1962 was 100. This total was reduced to 74 in 1972. The number of farms in Grant County was 70 in 1962 and 79 in 1972. The average size of farm in Arthur County is 6,439 acres; the average size in Grant County is 10,414 acres.

Most ranches in Grant County have adequate hay for winter feed. Arthur County has a greater need for winter feed, especially in the southern and western parts. The pattern and distribution of soils that are suited to tillage limit the opportunity for extensive cultivation. Future development of these soils for use as cropland will probably await changes in ranch organization. At present the need to increase the amount of winter feed is limited to a few ranches, mostly in Arthur County.

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Glossary

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (ph 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity. The capacity of soils to hold water available for use by most plants, usually expressed as inches of water per inch of soil. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. This difference multiplied by the bulk density and divided by 100 gives a value in surface inches of water per inch depth of soil. In this survey, the classes of available water capacity for a 60-inch profile or to a limiting layer are:

Very low	0 to 3 inches
Low	3 to 6 inches
Moderate	6 to 9 inches
High	9 inches or more

Blowout. An excavation produced by wind action in loose soil, usually sand.

Bunch grass. A grass that grows in tufts, in contrast to a sod-forming grass.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder of individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Dune. A mound or ridge of loose sand piled up by the wind.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes, or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Friability. The condition of a soil that crumbles easily.

Gleyed soil. A soil in which waterlogging and lack of oxygen have caused the material in one or more horizons to be neutral gray in color. The term "gleyed" is applied to soil horizons with yellow and gray mottling caused by intermittent waterlogging.

Grazing capacity. The maximum number of animals or animal units per acre, or acres per animal unit, that a grazing area can support adequately without deterioration; sometimes called carrying capacity.

Habitat. The natural abode of a plant or animal; it refers to the kind of environment in which a plant or animal normally lives as opposed to its range, or geographical distribution.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath the A or B horizon.

Humus. The well-decomposed, more or less stable part of the organic matter in mineral soils.

Immature soil. A soil lacking clearly defined horizons because the soil-forming forces have acted on the parent material only a relatively short time since it was deposited or exposed.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Land classification. The classification of units of land for the purpose of showing their relative suitabilities for some specific use.

Landscape. All the characteristics that distinguish a certain kind of area on the earth's surface and give it a distinguishing pattern, in contrast to other kinds of areas. Any one kind of soil is said to have a characteristic natural landscape, and under different uses it has one or more characteristic cultural landscapes.

Legume. A member of the legume or pulse family (*Leguminosae*). One of the most important and widely distributed plant families. It includes many valuable forage species, such as peas, beans, peanuts, clover, alfalfa, sweet clover, lespedeza vetch, and kudzu. Practically all legumes are nitrogen-fixing plants, and many of the herbaceous species are used as cover and green-manure crops. Even some of the legumes that have no forage value (crotalaria and some lupines) are used for soil improvement. Other legumes are locust, honeylocust, redbud, mimosa, wisteria, and many tropical plants.

Loess. A fine-grained eolian deposit consisting dominantly of silt-sized particles.

Mature soil. Any soil with well-developed soil horizons having characteristics produced by the natural processes of soil formation and in near equilibrium with its present environment.

Mineral soil. Soil composed mainly of inorganic (mineral) material and low in content of organic material. Its bulk density is greater than that of organic soil.

Mottled. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few*, *common*, and *many*; size—*fine*, *medium*, and *coarse*; and contrast—*faint*, *distinct*, and *prominent*. The size measurements are these: *fine*, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium*, ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse*, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Natural soil drainage. Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and Podzolic soils commonly have mottlings below 6 to 16 inches in the lower part of the A horizon and in the B and C horizons.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Organic matter (soil). The organic fraction of the soil. It includes plant and animal residues at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population. It is commonly determined as those organic materials that accompany the soil when put through a 2-mm sieve. In this survey, organic matter was rated as follows:

Very low	Less than 0.5 percent
Low	0.5 to 1.0 percent
Moderately low	1.0 to 2.0 percent
Moderate	2.0 to 4.0 percent

Parent material. The disintegrated and partly weathered rock from which soil has formed.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability, soil. The quality of a soil that enables water or air to move through it. In this survey, permeability applies to that part of the soil below the A horizon and above a depth of 60 inches, or to bedrock that occurs at a shallower depth. Classes of permeability of a saturated soil in inches of water per hour are as follows:

Very slow	less than 0.06
Slow	0.06 to 0.2
Moderately slow	0.2 to 0.6
Moderate	0.6 to 2.0
Moderately rapid	2.0 to 6.0
Rapid	6.0 to 20.0
Very rapid	more than 20

pH value. A numerical means for designating relatively weak acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Poorly graded. A soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles in poorly graded soil material, density can be increased only slightly by compaction.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher.

Relief. The elevations or inequalities of a land surface considered collectively.

Saline-Alkali soil. A soil that contains a harmful concentration of salts and exchangeable sodium, contains harmful salts and has a highly alkaline reaction, or contains harmful salts and exchangeable sodium and is strongly alkaline in reaction. The salts, exchangeable sodium, and alkaline reaction occur in the soil in such location that growth of most crop plants is less than normal.

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeters) to the lower limit of very fine sand (0.05 millimeters). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Slope (soil). The deviation of a surface from the horizontal, usually expressed in percent or degrees. In this survey, the following slope classes are recognized:

Simple slopes	*Complex slopes*	*Percent*
Nearly level	Nearly level	0 to 2 percent
Very gently sloping	Gently undulating	1 to 3 percent
Strongly sloping	Gently rolling	3 to 9 percent
----------------	Rolling	3 to 17 percent
----------------	Rolling and hilly	3 to 60 percent
----------------	Hilly	9 to 60 percent

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Terrace (engineering). An embankment or ridge constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surplus runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportions of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Transitional soil. A soil somewhat resembling two different kinds of soils and genetically related to them.

Underlying material. That part of the soil immediately beneath the solum.

Upland (geology). Land consisting of material unworked by water in recent geologic time and lying, in general, at a higher elevation than the alluvial plain or stream terrace. Land above the lowlands along rivers.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

Wilting point (or permanent wilting point). The moisture content of soil, on an oven-dry basis, at which plants (specifically sunflower) wilt so much that they do not recover when placed in a dark, humid atmosphere.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. Information about the use and management of each soil is given in the description of the capability unit and range site (or other interpretive group) to which it is assigned.

Map symbol	Mapping unit	Described on page	Capability unit Symbol	Capability unit Page	Range site Name	Windbreak suitability group Number
DdB	Doger and Dunday loamy fine sands, 0 to 3 percent slopes	7	IVe-5	19	Sandy	3
DdD	Doger and Dunday loamy fine sands, 3 to 9 percent slopes	8	VIe-5	20	Sandy	3
DfB	Doger and Dunday loamy fine sands, loamy substratum, 0 to 3 percent slopes	8	IVe-5	19	Sandy	3
EcB	Els fine sand, 0 to 3 percent slopes	10	VIw-5	21	Subirrigated	2
EdB	Els loamy fine sand, alkali, 0 to 3 percent slopes	10	VIs-1	21	Saline Lowland	10
EfB	Elsmere loamy fine sand, 0 to 3 percent slopes	11	IVw-5	19	Subirrigated	2
Ga	Gannett-Loup fine sandy loams, 0 to 2 percent slopes	12	Vw-7	20	Wet Land	6
Gb	Gannett-Loup fine sandy loams, drained, 0 to 2 percent slopes	12	Vw-7	20	Subirrigated	6
Ld	Loup-Gannett loamy fine sands, 0 to 2 percent slopes	14	Vw-7	20	Wet Land	6
Lf	Loup-Gannett loamy fine sands, drained, 0 to 2 percent slopes	14	Vw-7	20	Subirrigated	6
Ma	Marsh	14	VIIIw-7	22	-------------	10
Sa	Saline-Alkali land	14	VIs-1	21	Saline subirrigated	10
Tk	Tryon loamy fine sand, 0 to 2 percent slopes	16	Vw-7	20	Wet Land	6
Tn	Tryon loamy fine sand, drained, 0 to 2 percent slopes	16	Vw-7	20	Subirrigated	6
VaB	Valentine fine sand, 0 to 3 percent slopes	17	VIe-5	20	Sandy	7
VaE	Valentine fine sand, rolling	17	VIe-5	20	Sands	7
VaF	Valentine fine sand, rolling and hilly	17	VIIe-5	21	-------------	--
	Rolling part	--	-------	--	Sands	7
	Hilly part	--	-------	--	Choppy Sands	10
VaG	Valentine fine sand, hilly	18	VIIe-5	21	Choppy Sands	10

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