SOIL SURVEY OF
Edmunds County, South Dakota

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

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.

Major fieldwork for this soil survey was completed in the period 1964–72. Soil names and descriptions were approved in 1972. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1972. This survey was made cooperatively by the Soil Conservation Service and the South Dakota Agricultural Experiment Station. It is part of the technical assistance furnished to the Edmunds County Conservation District.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms and ranches; 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 Edmunds County are shown on the detailed map at the back of this survey. 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 county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil, capability unit, pasture group, or range site is described.

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 discussions of the capability units, the range sites, and the pasture and windbreak groups.

Ranchers and others can find, under "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.

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

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Wildlife."

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

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers in Edmunds County may be especially interested in the section "General Soil Map," where broad patterns of soil are described. They may also be interested in the information about the county given in the section "Environmental Factors Affecting Soil Use."

Cover: Area of Marsh in the Williams-Vida soil association provides habitat for wildlife.

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SOIL SURVEY OF EDMUNDS COUNTY, SOUTH DAKOTA

BY EDGAR H. ENSZ, SOIL CONSERVATION SERVICE

SOILS SURVEYED BY EDGAR H. ENSZ, MERLE M. KOST, ADRIAN A. PARMETER, THOMAS M. SCHUMACHER, AND LOREN D. SCHULTZ, SOIL CONSERVATION SERVICE [1]

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

EDMUNDS COUNTY, in the north-central part of South Dakota (fig. 1), is 48 miles from east to west and 24 miles from north to south. The total area is 739,200 acres. The population in 1970 was 5,548. Ipswich, the county seat, is the largest town. Smaller towns and villages are Bowdle, Craven, Hosmer, Loyalton, Mina, and Roscoe.

Edmunds County is in two physiographic areas. The central and western parts are on the Missouri Coteau (*3*) [2] where relief is mostly undulating to hilly, and elevation differences range to as much as 100 feet. Many potholes or closed depressions are in this part of the county, and the drainage pattern is poorly defined. The eastern part of the county is on the Drift Prairie portion of the James River Lowland. Relief is mostly nearly level to gently sloping in this part of the county. Elevation differences range from 10 to 30 feet. The drainage pattern is better defined in this part of the county. The two principal streams are Preachers Run and Snake Creek. They flow southeast to the James River.

About 70 percent of the county is cropped. Spring wheat, oats, corn, rye, and alfalfa are the main crops. Growing cash crops, mainly wheat, raising beef cattle, and dairying are the main farm enterprises.

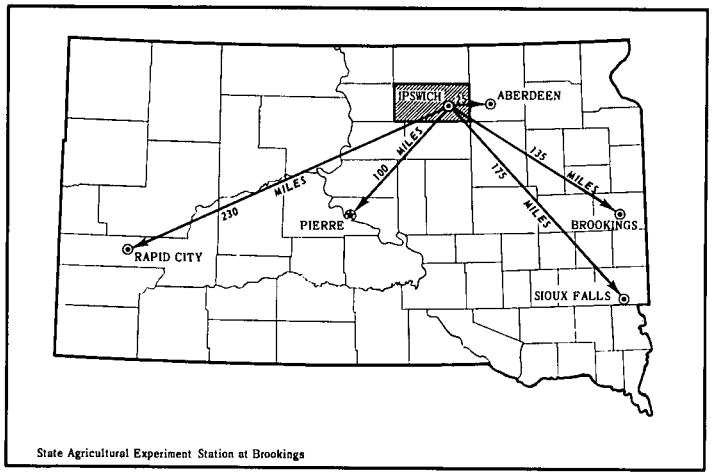


Figure 1.—Location of Edmunds County in South Dakota.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Edmunds County, where they are located, and how they can be used. The soil scientists went into the county 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* and the *soil phase* are the categories 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. Bowdle and Williams, 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, Bryant loam, 0 to 2 percent slopes, is one of several phases within the Bryant series.

[1] Others who assisted in the soil survey were GARY J. DELANEY, KENNETH J. HEIL, ARVID C. MELAND, and VERNON W. MOXON, Soil Conservation Service.

[2] Italic numbers in parentheses refers to Literature Cited, p. 79.

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 survey 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 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. One such kind of mapping unit, the soil complex, is shown on the soil map of Edmunds County.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size 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. Williams-Bowbells loams, 3 to 6 percent slopes, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, 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. Marsh 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 kind 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 kind of soil. Yields under defined management are estimated for all the soils.

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants, and as material for structures, foundations for structures, or covering for structures. They relate this 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 named kind of soil, and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark soils in a survey area, the soil scientists set up trial groups of soils. They test these groups according to the results of their studies and consultation. 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 Edmunds County. 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, or a wildlife area, or in planning engineering works, recreational facilities, and 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 headings of the associations apply to the texture of the surface layer. For example, in the subtitle of the Niobell-Noonan association, the word "loamy" refers to the texture of the surface layer.

The soil associations in Edmunds County are described on the following pages.

1. Niobell-Noonan association

Deep, moderately well drained, nearly level to gently sloping loamy soils that have a claypan subsoil and formed in glacial till

This association is a glacial till plain, mainly of flats and rises interrupted by a few swales and shallow closed depressions. It is mostly nearly level to gently sloping, but is steeper along the larger drainageways. Differences in elevation range from 10 to 30 feet. Drainageways such as Snake Creek are well defined, but others are sluggish and the drainage pattern is poorly defined.

This association makes up about 14 percent of the county. It is about 25 percent Niobell soils, 20 percent Noonan soils, and 55 percent soils of minor extent (fig. 2).

The Niobell soil, on flats and slight rises, has a surface layer of dark grayish-brown loam and a subsurface layer of dark-brown, friable clay loam. The claypan subsoil, at a depth of 16 inches, is grayish-brown, light olive-brown, and light yellowish-brown, firm clay loam. The underlying material is calcareous, light brownish-gray clay loam.

The Noonan soil is closely intermingled with the Niobell soil. It has a surface layer of dark grayish-brown loam and a subsurface layer of light brownish-gray loam. The claypan subsoil, at a depth of 10 inches, is dark grayish-brown and light olive-brown clay loam. The underlying material is calcareous, light brownish-gray clay loam.

Heil and Williams soils are the most extensive minor soils. Heil soils are in shallow closed depressions, and

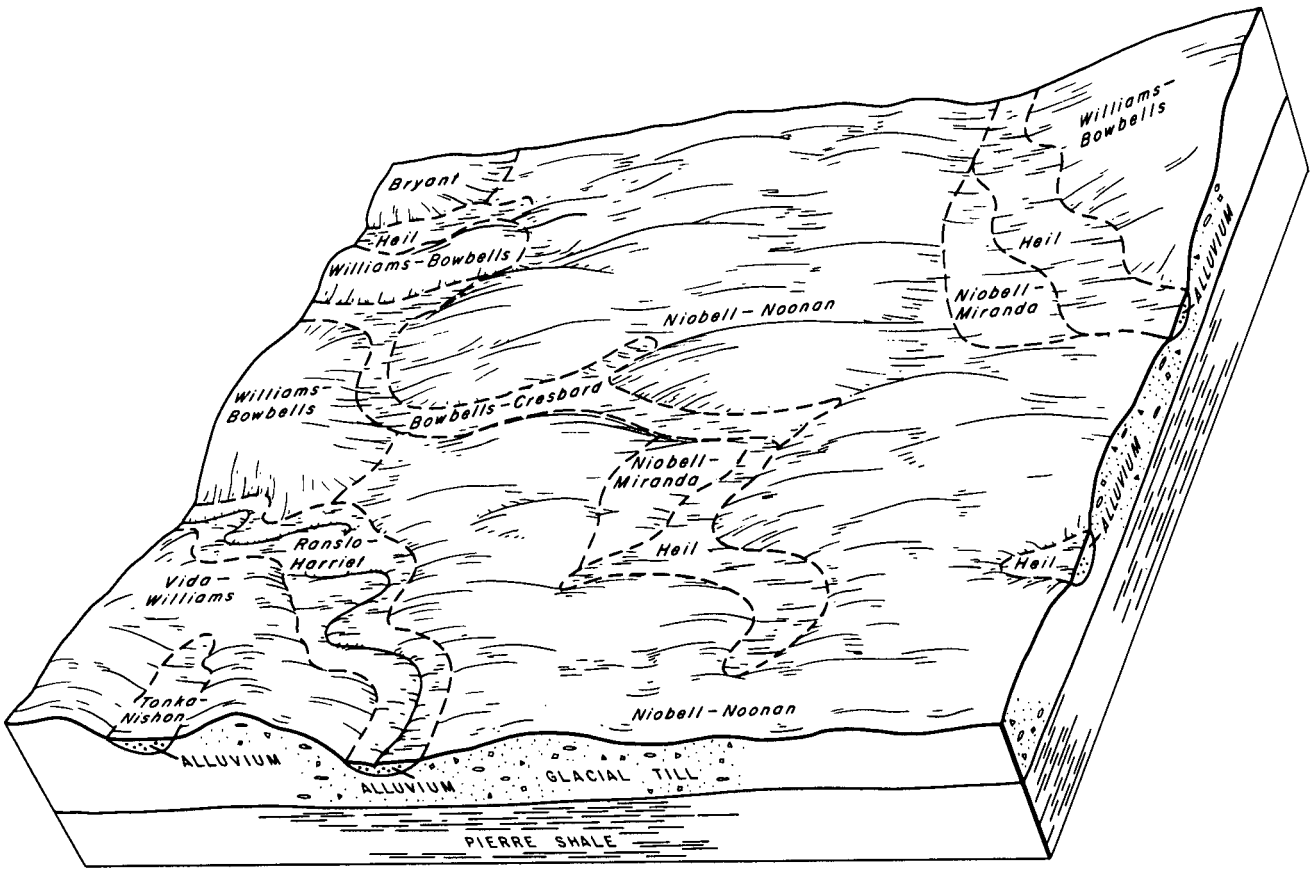


Figure 2.—**Topography, soils, and underlying material in Niobell-Noonan association.**

Williams soils are on the high parts of the landscape. Less extensive soils are Bowbells soils in swales; Bryant, Tally, and Vida soils on the high parts; Harriet and Ranslo soils on bottom land; Miranda soils intermingled with Niobell and Noonan soils; and Nishon and Tonka soils in some closed depressions.

The major soils in this association have medium or low fertility. Their claypan subsoil takes in water slowly and limits plant roots. Runoff is slow to medium and ponds in the closed depressions. Improving water intake, conserving moisture, controlling erosion and soil blowing, and maintaining fertility and tilth are concerns of management.

Much of this association is cultivated, but the closed depressions and some sloping soils are still in native grass and are used for grazing and hay. Spring-sown small grain and alfalfa are the main crops. Growing cash crops and feeding beef cattle are the main farm enterprises.

2. *Bryant association*

Deep, well drained, nearly level to sloping loamy soils formed in glacial drift

This association is a glacial drift plain that is somewhat lower in elevation than the adjacent Williams-Bowbells association. It is mostly nearly level to gently sloping. Slopes are long and smooth. Steeper slopes are along the larger drainageways. A few closed depressions are in the area, but otherwise the drainage pattern is well defined.

This association makes up about 11 percent of the county. It is about 55 percent Bryant soils and 45 percent soils of minor extent.

The Bryant soil has a surface layer of dark grayish-brown loam and a subsoil of grayish-brown and light brownish-gray clay loam. The underlying material is calcareous, light brownish-gray and yellowish-brown clay loam.

Grassna soils, the most extensive of the minor soils, are in swales. Less extensive are Bowbells soils in swales, Loamy Fluvaquents and Harriet and Ranslo soils on bottom land along drainageways, Niobell and Noonan soils on flats and slight rises, Nishon and Tonka soils in closed depressions, and Tally soils on the higher parts of the landscape.

The dominant Bryant soil has medium fertility and high available water capacity. Runoff is slow to medium, and permeability is moderate. Conserving moisture, controlling erosion and soil blowing, and maintaining fertility are the main concerns of management.

Most of this association is cultivated. Corn, wheat, oats, rye, and alfalfa are the main crops. Some sloping areas are in native or tame grass and are used for pasture. Diversified farming is the main enterprise.

3. *Williams-Bowbells association*

Deep, well drained and moderately well drained, nearly level to undulating loamy soils formed in glacial till

This association is a glacial till plain, mainly of rises interrupted by narrow swales and sags and many closed depressions or potholes (fig. 3). Slopes generally are short and the soils are mostly gently undulating, but some areas are nearly level and some are undulating or steeper around the potholes. Differences in elevation range from 10 to 30 feet. The drainage pattern is poorly defined in much of the association.

This association makes up about 51 percent of the county. It is about 40 percent Williams soils, 20 percent Bowbells soils, and 40 percent soils of minor extent.

Williams soils are on the rises and are well drained. The surface layer is dark grayish-brown loam and the subsoil is grayish-brown and light brownish-gray clay loam. The underlying material is calcareous, light-gray and light yellowish-brown clay loam.

Bowbells soils are in swales and are moderately well drained. They have a surface layer of dark grayish-brown loam and a thick subsoil of dark grayish-brown brown, and grayish-brown clay loam. The underlying material is calcareous, light brownish-gray clay loam.

The minor soils in this association are Bryant, Mondamin, Temvik, and Vida soils on the higher parts of the landscape; Cresbard soils in some swales; Heil, Nishon, Parnell, and Tonka soils in closed depressions; and Niobell and Noonan soils on flats and some slight rises.

The major soils have medium or high fertility and high available water capacity. Runoff is mostly medium and ponds in the closed depressions. Permeability is moderate in the subsoil, but is moderately slow in the underlying glacial till. Conserving moisture, controlling erosion and soil blowing, and maintaining fertility are the main concerns of management.

Much of this association is cultivated. Corn, wheat, oats, rye, and alfalfa are the main crops. Some areas are still in native grass and are used for grazing and hay. Growing cash crops and feeding beef cattle are the main farm enterprises.

4. *Williams-Vida association*

Deep, well-drained, gently undulating to hilly loamy soils formed in glacial till

This association is a glacial till plain, mainly of ridges and knolls interrupted by narrow swales that terminate in closed depressions. Slopes generally are short and the soils are mostly undulating to hilly. Differences in elevation range from 30 to 100 feet. Many of the depressions are deeply entrenched and the drainage pattern is poorly defined. Stones and boulders are on some of the ridges and knolls.

This association makes up about 15 percent of the county. It is about 40 percent Williams soils, 20 percent Vida soils, and 40 percent soils of minor extent.

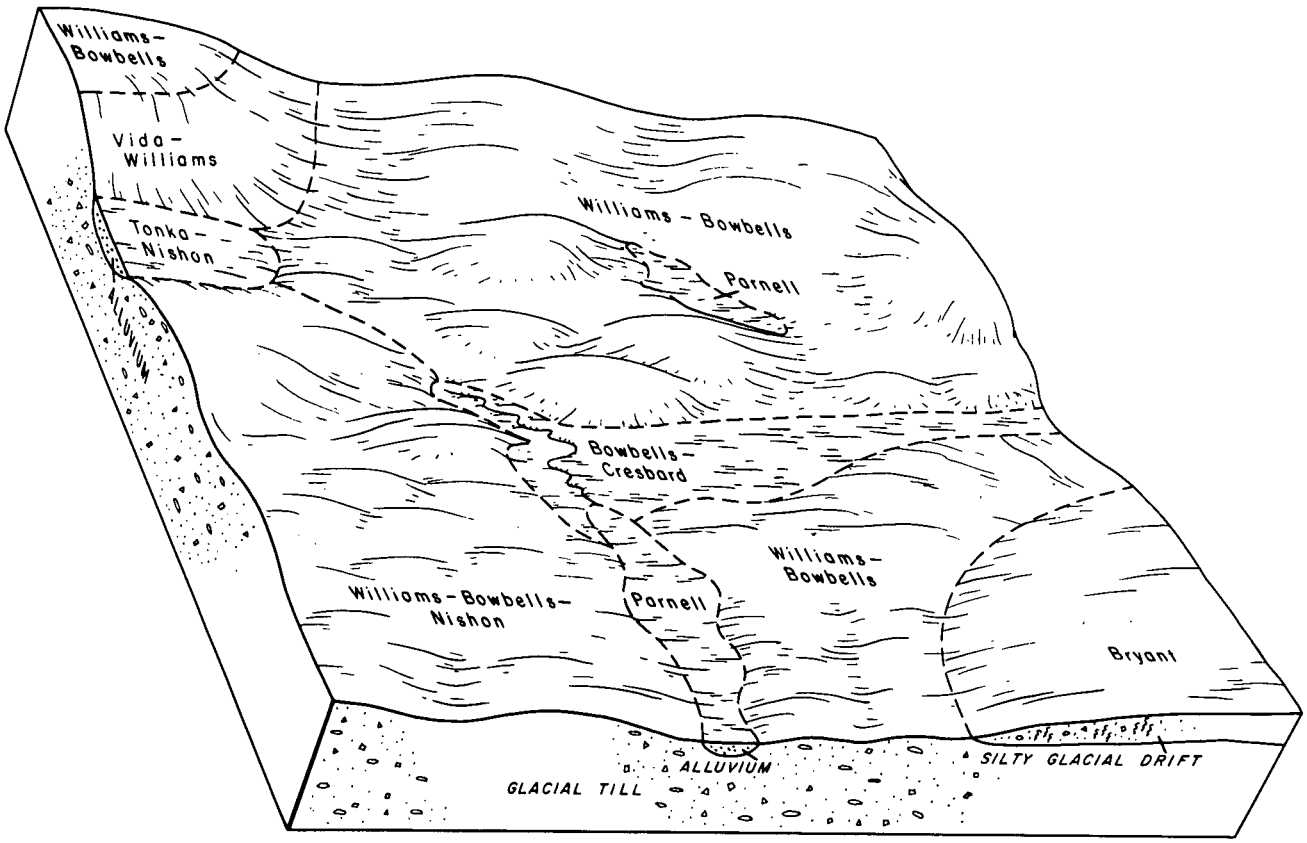


Figure 3.—**Topography, soils, and underlying material in Williams-Bowbells association.**

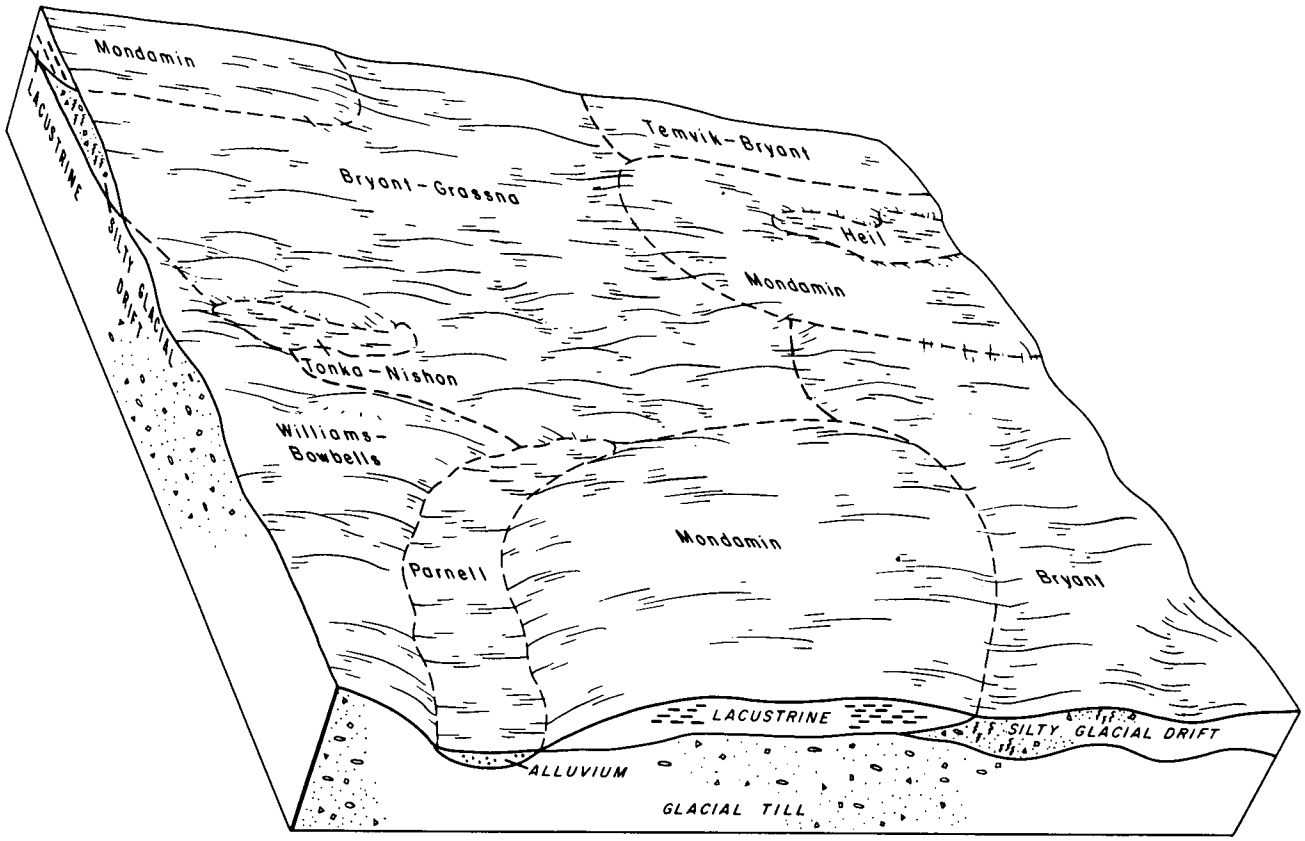


Figure 4.—**Topography, soils, and underlying material in Bryant-Mondamin association.**

Williams soils are mostly on the mid and lower parts of the landscape. They have a surface layer of dark grayish-brown loam and a subsoil of grayish-brown and light brownish-gray clay loam. The underlying material is calcareous, light-gray and light yellowish-brown clay loam.

Vida soils are on the higher parts of the landscape and are mostly rolling to hilly. They have a surface layer of dark grayish-brown loam, and the subsoil is dark grayish-brown and light brownish-gray clay loam. The underlying material is calcareous, light brownish-gray and pale-yellow clay loam.

Bowbells soils in swales and Parnell soils in closed depressions are the most extensive minor soils. Less extensive are Bryant and Temvik soils in places that are mantled by glacial drift, Cresbard soils in some swales, Niobell and Noonan soils on flats and slight rises above the swales, Nishon and Tonka soils in some depressions, and Wabek and Zahill soils on the higher parts of the landscape.

The major soils in this association have medium fertility and high available water capacity. Runoff is medium, and the hazard of erosion is moderate to severe. Controlling erosion and maintaining fertility are the main concerns of management, but conserving moisture also is important. The short irregular slopes, the many potholes and sloughs, and the stones and boulders scattered on the surface in some areas limit the use of these soils for cultivation.

Most of this association is still in native grass and is used for hay and pasture. Spring-sown small grain and alfalfa are the main crops in the small cultivated areas. Raising beef cattle is the main farm enterprise.

5. *Bryant-Mondamin association*

Deep, well drained to moderately well drained, nearly level to gently sloping loamy and silty soils formed in glacial drift and lacustrine sediments

This association is in scattered areas where the glacial till plain is mantled by glacial drift and lacustrine sediments of ice-walled lakes (fig. 4). Slopes generally are long and smooth but in places are gently undulating. A few closed depressions are scattered throughout the areas and the drainage pattern is poorly defined.

This association makes up about 3 percent of the county. It is about 40 percent Bryant soils, 30 percent Mondamin soils, and 30 percent soils of minor extent.

Bryant soils are well drained. They formed in glacial drift that has a high content of silt and very fine sand. The surface layer is dark grayish-brown loam and the subsoil is grayish-brown and light brownish-gray clay loam. The underlying material is calcareous, light brownish-gray and yellowish-brown clay loam.

Mondamin soils are well drained and moderately well drained and are on mesalike flats. They formed in lascustrine sediments. The surface layer is dark

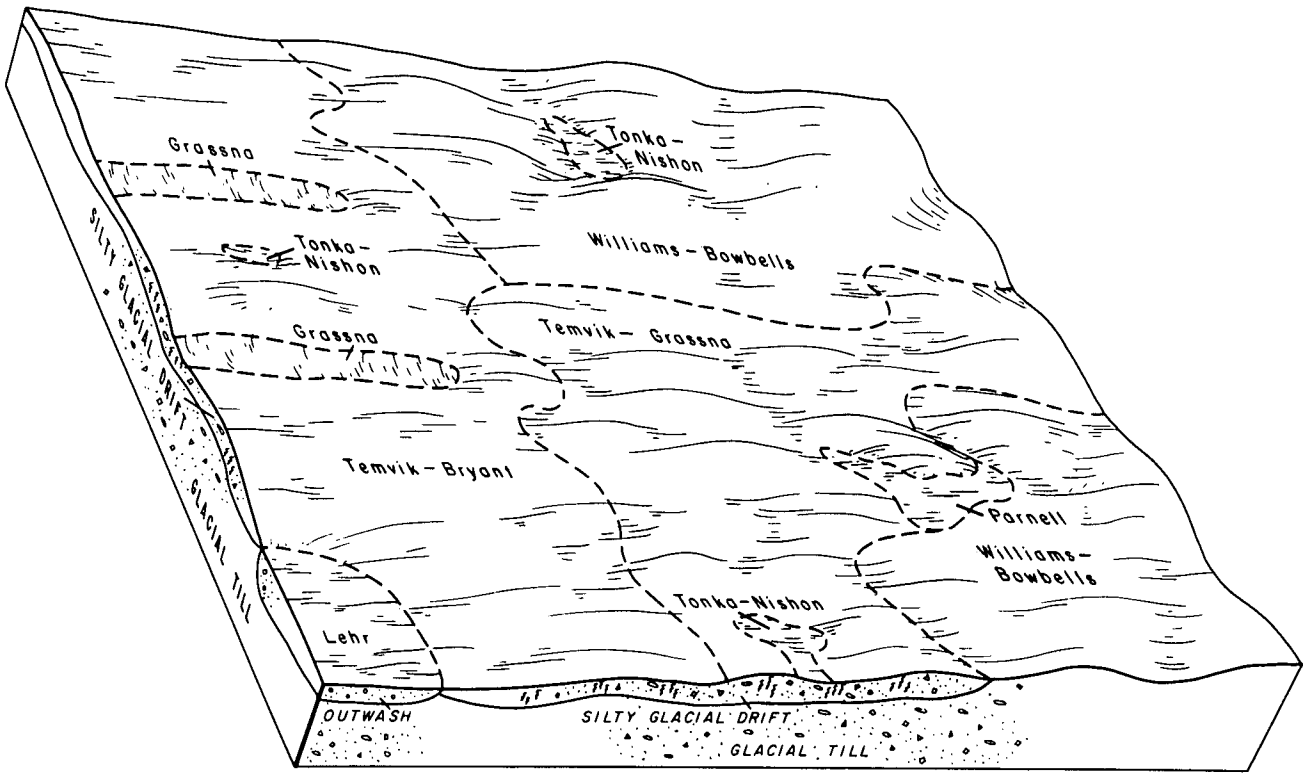


Figure 5.—**Topography, soils, and underlying material in Temvik-Williams association.**

grayish-brown silty clay loam, and the subsoil is dark grayish-brown silty clay in the upper part and light brownish-gray and grayish-brown silty clay loam in the lower. The underlying material is calcareous, light brownish-gray and light-gray silty clay loam.

Williams and Parnell soils are the most extensive of the minor soils. Williams soils are in places where the glacial till is not mantled by glacial drift or lacustrine sediments. Parnell soils are in closed depressions. Less extensive are Bowbells and Grassna soils in swales; Heil, Nishon, and Tonka soils in some depressions; and Temvik soils on the higher parts of the landscape with Bryant soils.

The major soils in this association have medium to high fertility and high available water capacity. Permeability is moderate in the Bryant soil, but the Mondamin soil takes in water slowly and releases it slowly to plants. If cultivated, the Mondamin soil loses its tilth and the hazard of soil blowing is moderate. Improving water intake on the Mondamin soil, controlling erosion and soil blowing, conserving moisture, and maintaining tilth and fertility are concerns of management.

Most of this association is cultivated. Corn, wheat, oats, rye, and alfalfa are the main crops. Growing cash crops, feeding beef cattle, and dairying are the main farm enterprises.

6. *Temvik-Williams association*

Deep, well-drained, gently sloping to undulating loamy soils formed in glacial drift and glacial till

This association is a glacial till plain that is thinly mantled with glacial drift material. The drift material has a high content of silt and very fine sand. It ranges from 1 to several feet in thickness over the glacial till, but in places it is absent. The soils are mostly gently sloping, but some are undulating and some places include small areas of nearly level soils. Numerous swales and a few closed depressions are in the areas, but the drainage pattern is well defined.

This association makes up about 4 percent of the county. It is about 25 percent Temvik soils, 20 percent Williams soils, and 55 percent soils of minor extent (fig. 5).

Temvik soils formed in glacial drift over glacial till. They have a surface layer of dark grayish-brown loam and a subsoil of dark grayish-brown and light olive-brown loam. The underlying material to a depth of 37 inches is calcareous, light olive-brown loam. Below this is calcareous, light brownish-gray clay loam.

Williams soils formed in glacial till and are in places where the glacial drift material is less than 1 foot thick or is absent. They have a surface layer of dark grayish-brown loam and a subsoil of grayish-brown and light

brownish-gray clay loam. The underlying material is calcareous, light-gray and light yellowish-brown clay loam.

Bowbells, Bryant, and Grassna soils are the most extensive of the minor soils. Bowbells and Grassna soils are in swales. Bryant soils are intermingled with Temvik soils. Less extensive are Bowdle and Lehr soils in places underlain by sand and gravel; Nishon, Parnell, and Tonka soils in some closed depressions; and Vida soils on ridgetops near Williams soils.

The major soils in this association have medium fertility and high available water capacity. Runoff is medium, and there is a moderate to severe hazard of erosion. Permeability is moderate in the subsoil and moderately slow in the underlying glacial till. Controlling erosion, conserving moisture, and maintaining fertility are the main concerns of management.

Most of this association is cultivated. Corn, wheat, oats, rye, and alfalfa are the main crops. Diversified livestock farming is the main enterprise.

7. *Lehr-Bowdle association*

Somewhat excessively drained and well drained, nearly level to undulating loamy soils that are shallow and moderately deep to outwash sand and gravel; formed in alluvium

This association is a glacial outwash plain that is somewhat lower in elevation than the nearby Temvik-Williams association. It is mostly nearly level to gently sloping, but steeper areas are on the sides of drainageways. Slopes generally are long and smooth, but some are short and irregular. Very few closed depressions are in the areas, and the drainage pattern is well defined.

This association makes up about 2 percent of the county. It is about 40 percent Lehr soils, 30 percent Bowdle soils, and 30 percent soils of minor extent (fig. 6).

Lehr soils are shallow to sand and gravel and are somewhat excessively drained to well drained. They have a surface layer of dark grayish-brown loam. The upper part of the subsoil is dark grayish-brown loam and the lower part is calcareous, grayish-brown sandy loam. Calcareous, light-gray and light brownish-gray sand and gravel are at a depth of 16 inches.

Bowdle soils are moderately deep to sand and gravel and are well drained. They have a surface layer and subsoil of dark grayish-brown loam. Calcareous sand and gravel are at a depth of 25 inches.

Bryant, Temvik, and Williams soils are the most extensive of the minor soils. They are scattered throughout the areas in places where the outwash

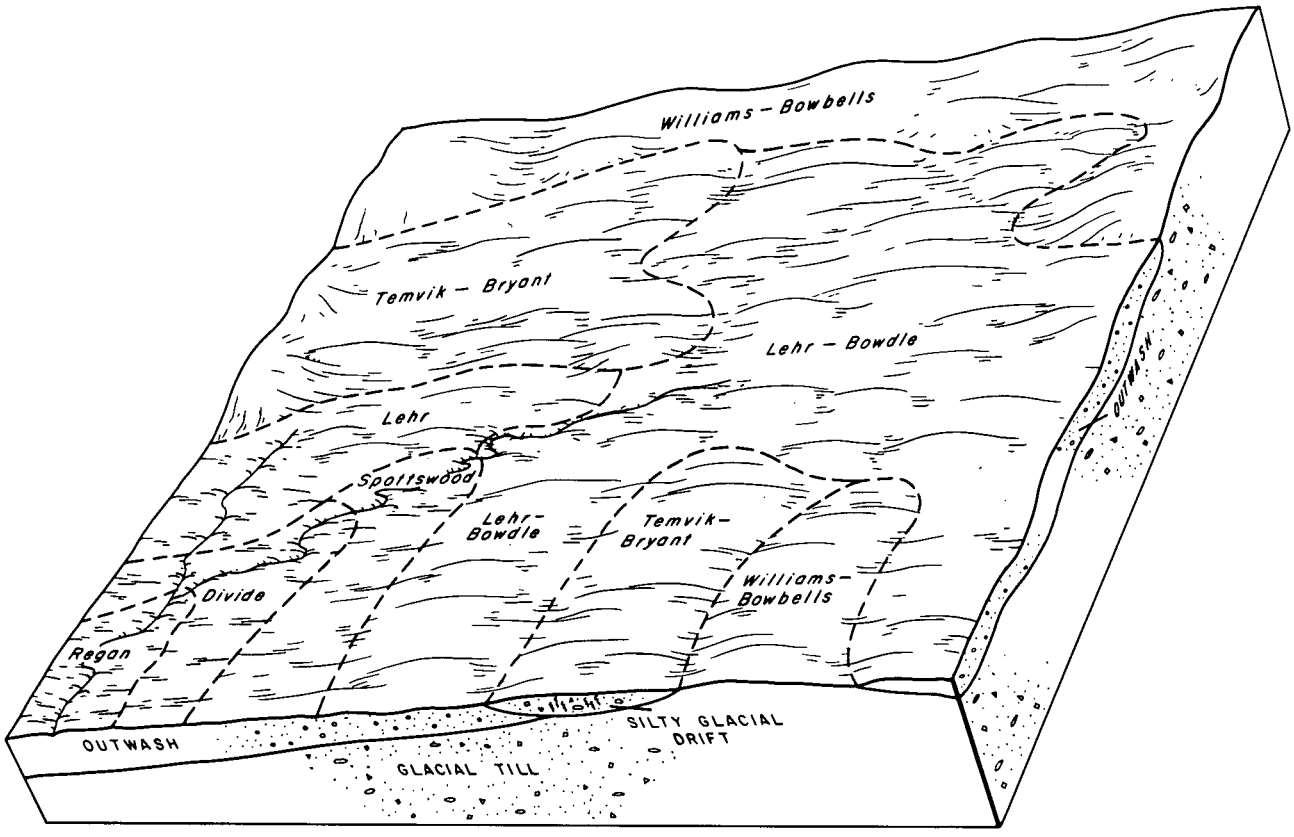


Figure 6.—**Topography, soils, and underlying material in Lehr-Bowdle association.**

sand and gravel is absent. Less extensive are Bearden, Bowbells, Divide, Grassna, and Spottswood soils in swales and along drainageways; Regan soils on bottom land; Vida soils on the higher parts of the landscape with Williams soils; and Wabek soils on the crests of ridges and knolls.

The major soils in this association have low to medium fertility and low to moderate available water capacity. They are droughty. Permeability is moderate in the subsoil and is rapid in the underlying sand and gravel. Conserving moisture, controlling erosion and soil blowing, and maintaining fertility are concerns of management.

Most of this association is cultivated. Wheat, oats, and rye are the main crops. Some areas are still in native grass and are used for pasture and hay. Diversified livestock farming is the main enterprise.

Descriptions of the Soils

This section describes the soil series and mapping units in Edmunds County. A soil series is described in detail, and then, briefly, each mapping unit in that series. Unless it is specifically mentioned otherwise, 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 differs from the one described for the series, the differences are stated in describing the mapping unit, or they 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. Such miscellaneous areas as Loamy Fluvaquents and Marsh, for example, do not belong to a soil series, but nevertheless, are listed in alphabetic order along with the soil series.

Preceding the name of each mapping unit is a symbol which identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit, range site, and windbreak group in which the mapping unit has been placed. The page for the description of each capability unit, range site, or pasture group 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 (*8*).

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

Soil	Area	Extent	Soil	Area	Extent
	Acres	*Percent*		*Acres*	*Percent*
Bearden loam	1,250	0.2	Parnell silty clay loam	32,300	4.3
Bowbells-Cresbard loams	16,500	2.2	Ranslo-Harriet silt loams	11,200	1.5
Bowdle loam, 0 to 2 percent slopes	1,450	.2	Regan silt loam	650	.1
Bowdle loam, 2 to 6 percent slopes	1,100	.2	Spottswood loam	1,350	.2
Bryant loam, 0 to 2 percent slopes	31,600	4.3	Tally fine sandy loam, 2 to 6 percent slopes	3,550	.5
Bryant loam, 2 to 6 percent slopes	21,800	3.0	Temvik-Bryant loams, 2 to 6 percent slopes	2,050	.3
Bryant loam, 6 to 9 percent slopes	1,950	.3	Temvik-Grassna loams, 3 to 6 percent slopes	11,600	1.5
Bryant loam, sandy substratum, 1 to 3 percent slopes	1,060	.1	Temvik-Grassna loams, 6 to 9 percent slopes	3,100	.4
Bryant-Grassna loams, 2 to 6 percent slopes	18,800	2.5	Tonka-Nishon silt loams	24,300	3.3
Divide loam	1,150	.2	Vida stony loam, 3 to 15 percent slopes	5,000	.7
Edgeley loam, 6 to 20 percent slopes	790	.1	Vida-Williams loams, 6 to 15 percent slopes	31,800	4.3
Grassna loam	2,500	.3	Vida-Zahill loams, 15 to 25 percent slopes	8,600	1.1
Heil silt loam	16,900	2.3	Wabek loam, 6 to 20 percent slopes	570	.1
Lehr loam, 0 to 3 percent slopes	1,700	.2	Wabek-Bowdle loams, 6 to 15 percent slopes	2,500	.3
Lehr loam, 3 to 6 percent slopes	1,900	.3	Williams-Bowbells loams, 3 to 6 percent slopes	126,000	17.0
Lehr-Bowdle loams, 0 to 6 percent slopes	4,800	.7	Williams-Bowbells loams, 6 to 9 percent slopes	45,400	6.1
Letcher fine sandy loam	800	.1	Williams-Bowbells-Nishon complex, 0 to 2 percent slopes	38,500	5.2
Loamy Fluvaquents	5,000	.7	Williams-Bowbells-Nishon complex, 2 to 6 percent slopes	141,772	19.2
Marsh	7,000	1.0	Williams-Bowbells-Parnell complex, 6 to 9 percent slopes	17,200	2.3
Mondamin silty clay loam, 0 to 2 percent slopes	7,400	1.0	Gravel pits	340	(1)
Mondamin silty clay loam, 2 to 6 percent slopes	3,100	.4	Water areas greater than 40 acres	768	.1
Mondamin-Heil silty clay loams	3,400	.5			
Niobell-Miranda loams, 0 to 3 percent slopes	10,300	1.4	Total	739,200	100.0
Niobell-Noonan loams, 1 to 5 percent slopes	68,400	9.3			

[1] Less than 0.05 percent.

Bearden Series

The Bearden series consists of deep, somewhat poorly drained, nearly level, calcareous loamy soils on uplands. These soils formed in silty glacial drift or in lacustrine sediments. The native vegetation was mainly tall and mid grasses.

In a representative profile the surface layer is dark-gray loam about 9 inches thick. The next layer is about 3 inches of gray and light-gray loam. The underlying material to a depth of 40 inches is light-gray and light brownish-gray silt loam. Below this it is light-gray silty clay loam.

Bearden soils have moderate content of organic matter and medium fertility. Available water capacity is high, and permeability is moderately slow. Depth to a seasonal water table ranges from 3 to 5 feet.

Most of the acreage is cultivated.

Representative profile of Bearden loam, 2,000 feet west and 114 feet south of the northeast corner of sec. 17, T. 121 N., R. 73 W.

Ap—0 to 9 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate, fine and medium, granular structure; slightly hard, very friable, slightly sticky and slightly plastic; slight effervescence; moderately alkaline; abrupt, smooth boundary.

AC—9 to 12 inches, gray (10YR 5/1) and light gray (10YR 7/1) loam, very dark gray (10YR 3/1) and gray (10YR 5/1) moist; weak, coarse, subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline; abrupt, smooth boundary.

C1ca—12 to 29 inches, light-gray (2.5Y 7/2) silt loam, grayish brown (2.5Y 5/2) moist; massive; hard, friable, slightly sticky and slightly plastic; violent effervescence; moderately alkaline; clear, smooth boundary.

C2gcs—29 to 40 inches, light brownish-gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; common, fine, distinct mottles of brownish yellow (10YR 6/8) and light gray (10Y 7/1); laminated; hard, friable, slightly sticky and slightly plastic; common medium masses of gypsum; violent effervescence; moderately alkaline; clear, smooth boundary.

C3gcs—40 to 50 inches, light-gray (2.5Y 7/2) light silty clay loam, grayish brown (2.5Y 5/2) moist; many, fine, distinct mottles of brownish yellow (10YR 6/8) and light gray (10YR 7/1); laminated; hard, firm, sticky and plastic; common medium masses of gypsum; slight effervescence; moderately alkaline; clear, wavy boundary.

C4g—50 to 60 inches, light-gray (2.5Y 7/2) silty clay loam, grayish brown (2.5Y 5/2) moist; common, medium, distinct mottles of brownish yellow (10YR 6/8); laminated; hard, firm, sticky and plastic; slight effervescence; moderately alkaline.

Depth to laminated sediments ranges from 20 to 40 inches. In places the A horizon is very dark brown when moist. It is dominantly loam, but ranges to silt loam and silty clay loam. It is 8 to 15 inches thick. The C horizon above a depth of 40 inches is silty clay loam in places. The C1ca horizon is gray or light gray in hue of 2.5Y or 10YR and has a calcium carbonate equivalent that ranges from 15 to 45 percent. The lower part of the C horizon has few to many mottles. In places it is stratified with coarser textured materials.

Bearden soils are more poorly drained and are more calcareous than the nearby Bryant and Grassna soils.

Ba—Bearden loam. This nearly level soil is on uplands in swales and on broad flats. Areas are irregular in shape and range from 10 to 80 acres in size. Slopes are 0 to 2 percent and are slightly concave and smooth.

Included with this soil in mapping are Divide, Grassna, and Spottswood soils. Divide soils are on the margins of some areas. Grassna and Spottswood soils are on very slight rises.

This Bearden soil has a high content of lime. Soil blowing is a moderate hazard. In some years, fieldwork is delayed by wetness from a seasonal water table. Controlling soil blowing is the chief management need.

This soil is well suited to all crops commonly grown in the county. Most of the acreage is cultivated. Capability unit IIe–4; Silty range site; windbreak group 1.

Bowbells Series

The Bowbells series consists of deep, moderately well drained, nearly level to sloping loamy soils in swales on uplands. These soils formed in local alluvium and the underlying glacial till. The native vegetation was mainly tall and mid grasses.

In a representative profile the surface layer is dark grayish-brown loam about 6 inches thick. The subsoil, about 20 inches thick, is clay loam that is dark grayish brown in the upper part, brown in the middle part, and grayish brown in the lower part. The upper part is slightly hard when dry and friable when moist. The underlying material is calcareous, light brownish-gray clay loam.

Bowbells soils have high content of organic matter and high fertility. Available water capacity is high. Permeability is moderate in the subsoil and is moderately slow in the underlying material.

Much of the acreage is cultivated. A few areas are still in native grass and are used for hay and grazing.

Representative profile of Bowbells loam in an area of Williams-Bowbells loams, 3 to 6 percent slopes, 1,980 feet west and 75 feet north of the southeast corner of sec. 29, T. 123 N., R. 69 W.

A1—0 to 6 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate, fine and medium, granular structure; soft, friable, slightly sticky and slightly plastic; slightly acid; clear, smooth boundary.

B21t—6 to 11 inches, dark grayish-brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) moist; moderate, fine and medium, prismatic structure parting to moderate, medium, subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; shiny films on faces of blocks; neutral; clear, smooth boundary.

B22t—11 to 19 inches, brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; moderate, medium, prismatic structure parting to strong, fine and medium, blocky; hard, friable, sticky and plastic; shiny films on faces of blocks; common tongues (¼ to 1 inch wide) of dark grayish brown (10YR 4/2), very dark brown (10YR 2/2) moist; mildly alkaline; clear, smooth boundary.

B23t—19 to 26 inches, grayish-brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 3/2) moist; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky; hard, friable, sticky and plastic; shiny films on faces of blocks; few tongues (1¼ to 1½ inch wide) of dark grayish brown (10YR 4/2), very dark brown (10YR 2/2) moist; mildly alkaline; abrupt, wavy boundary.

C1ca—26 to 32 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; common, fine and medium, distinct mottles of strong brown (7.5YR 5/8) and light gray (10YR 7/1); very weak, coarse, prismatic structure; hard, friable, slightly sticky and slightly plastic; common

medium segregations of lime; violent effervescence; moderately alkaline; gradual, smooth boundary.

C2—32 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; common, fine and medium, distinct mottles of strong brown (7.5YR 5/8) and light gray (10YR 7/1); massive; hard, friable, slightly sticky and slightly plastic; common fine segregations of lime; strong effervescence; moderately alkaline.

Depth to carbonates ranges from 22 to 40 inches. Reaction ranges from medium acid to neutral in the A horizon and from slightly acid to mildly alkaline in the B2t horizon. In places the A horizon is dark gray. It is loam or silt loam and ranges from 5 to 15 inches in thickness. The B2t horizon ranges from dark grayish brown to pale brown in hue of 10YR or 2.5Y. Some pedons have a B3 horizon. The C horizon ranges from grayish brown to light yellowish brown in hue of 10YR or 2.5Y. Mottles are faint or distinct in the lower part of the B horizon or in the C horizon, but some pedons lack mottles. The C horizon commonly is clay loam, but ranges from loam to silty clay loam. Some pedons have few or common segregations of gypsum in the lower part of the C horizon.

Bowbells soils are in swales like Grassna soils and are near Williams soils. They contain less silt and very fine sand in the B horizon than Grassna soils. They have moist colors of very dark grayish brown or darker that extend to greater depths than in Williams soils.

Bc—Bowbells-Cresbard loams. This mapping unit is about 50 percent Bowbells soils, 30 percent Cresbard soils, and 20 percent other soils. Areas are long and narrow and range from 20 to 80 acres in size. Slopes are 0 to 2 percent. The soils are in swales and along drainageways on uplands. The Cresbard soil has the profile described as representative of the series, but in T. 122 N., R. 67 W. the surface layer is sandy loam in places.

Included with these soils in mapping are small areas of Nishon, Parnell, Ranslo, and Tonka soils. Nishon, Parnell, and Tonka soils are in small potholes, most of which are identified on the soil map by a wet spot symbol. Ranslo soils are in low areas where the swales merge into bottom land along drainageways.

Runoff is slow. In some years, fieldwork is delayed by wetness caused by runoff from adjacent soils, but in most years the additional moisture is beneficial. Soil blowing is a slight hazard on these soils. Conserving moisture is the chief management need.

These soils are well suited to all crops commonly grown in the county. Much of the acreage is cultivated. A few areas are in native grass and are used for grazing and hay. Capability unit IIc–3; Bowbells soil in Overflow range site, windbreak group 1; Cresbard soil in Clayey range site, windbreak group 4.

Bowdle Series

The Bowdle series consists of well-drained, nearly level to undulating loamy soils on uplands. These soils are moderately deep over sand and gravel. They formed in loamy alluvium. The native vegetation was a mixture of tall, mid, and short grasses.

In a representative profile the surface layer is dark grayish-brown loam about 8 inches thick. The subsoil, about 14 inches thick, is dark grayish-brown loam. The upper part is slightly hard when dry and friable when moist. The underlying material to a depth of 25 inches is calcareous, grayish-brown, gravelly loam. Below this, it is calcareous sand and gravel (fig. 7).

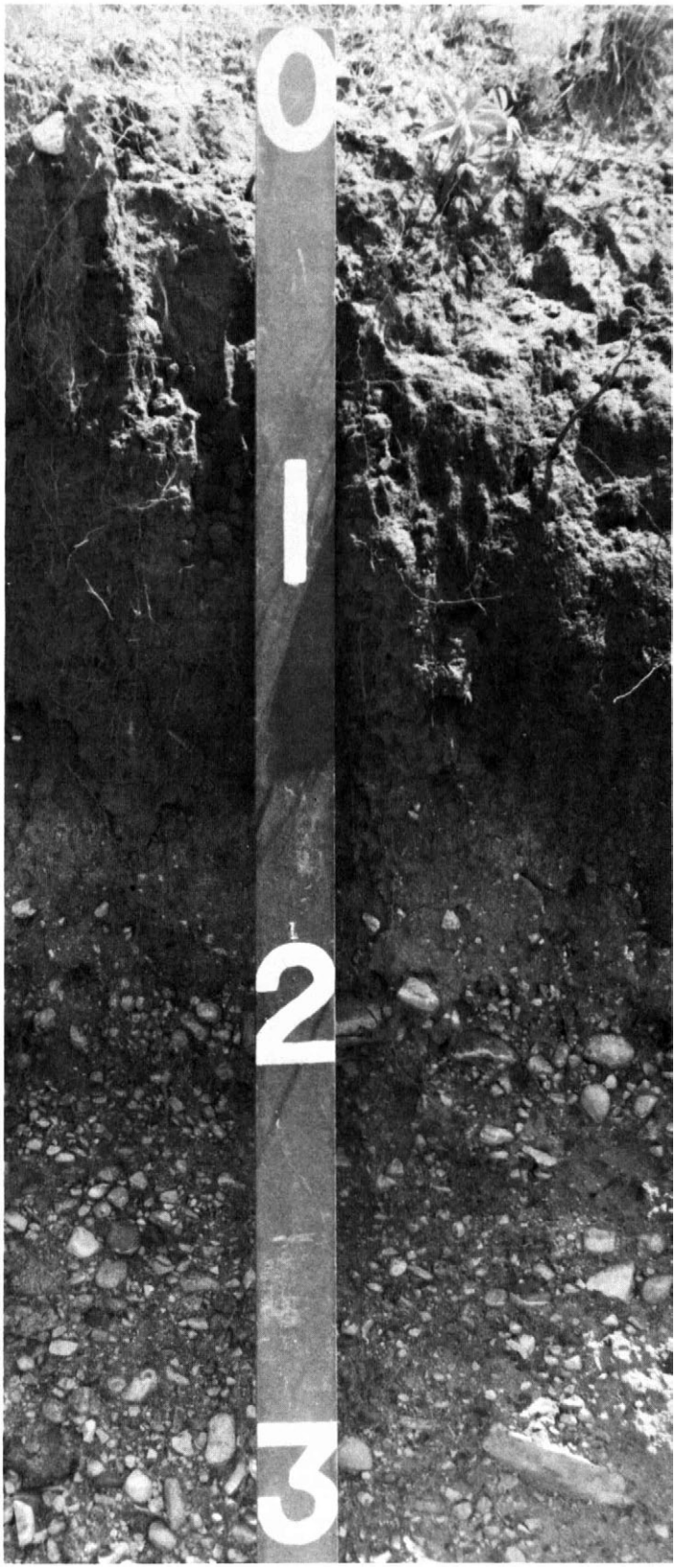


Figure 7.—**Profile of Bowdle loam showing sand and gravel at a depth of about 2 feet.**

Bowdle soils have moderate or high content of organic matter and medium fertility. Available water capacity is low or moderate, and permeability is moderate in the subsoil and rapid in the underlying sand and gravel.

Most of the acreage is cultivated. A few small areas are still in native grass and are used for grazing.

Representative profile of Bowdle loam, 0 to 2 percent slopes, 265 feet east and 230 feet south of the northwest corner of sec. 7, T. 122 N., R. 73 W.

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate, fine and medium, granular structure; soft, friable, slightly plastic; neutral; abrupt, smooth boundary.

B21—8 to 16 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate, medium, prismatic structure parting to moderate, medium, blocky and subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; neutral; clear, smooth boundary.

B22—16 to 22 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) crushing to very dark grayish brown (10YR 3/2) moist; moderate, coarse, prismatic structure parting to moderate, medium, subangular blocky; hard, friable, slightly sticky and slightly plastic; few lime coated pebbles; neutral; abrupt, wavy boundary.

C1ca—22 to 25 inches, grayish-brown (2.5Y 5/2) gravelly loam, very dark grayish brown (2.5Y 3/2) crushing to dark grayish brown (2.5Y 4/2) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; hard, very friable; common fine segregations of lime; strong effervescence; mildly alkaline; abrupt, wavy boundary.

IIC2—25 to 30 inches, varicolored loose sand and gravel; common fine shale fragments; strong effervescence; mildly alkaline; clear, smooth boundary.

IIC3—30 to 60 inches, varicolored loose sand and gravel; common fine shale fragments; slight effervescence; mildly alkaline.

Depth to free lime ranges from 14 to 32 inches. Depth to loose sand and gravel typically is 25 inches, but ranges from 20 to 40 inches. The A horizon is very dark grayish brown in some pedons. In places the B2 horizon is grayish brown. The B2 horizon has prismatic structure that is weak or moderate. It ranges from 10 to 24 inches in thickness. Some pedons have a B3 or B3ca horizon. Few or common, fine or medium, slightly rounded shale chips and fragments are in the IIC horizon.

Bowdle soils are near Divide, Lehr, and Spottswood soils. They are better drained than Divide and Spottswood soils. They are deeper to sand and gravel than Lehr soils.

BoA—Bowdle loam, 0 to 2 percent slopes. This nearly level soil is on uplands. Areas are irregular in shape and range from 10 to 240 acres in size. Slopes are long and smooth. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Divide, Lehr, and Spottswood soils. Divide and Spottswood soils are in low areas. Lehr soils are on very slight rises.

Runoff is slow. This soil is somewhat droughty because it is underlain by sand and gravel. There also is a slight hazard of soil blowing. Conserving moisture is the chief management need.

This soil is best suited to early maturing crops. Most of the acreage is cultivated. A few areas are still in native grass and are used for grazing. Capability unit IIIs–2; Silty range site; windbreak group 6.

BoB—Bowdle loam, 2 to 6 percent slopes. Areas of this soil are irregular in shape and range from 10 to 80 acres in size. Slopes are long and smooth. This soil has a profile similar to the one described as representative of the series, but the surface layer is slightly thinner. In some cultivated areas the surface layer has been mixed with the subsoil by plowing.

Included with this soil in mapping are small areas of Lehr and Spottswood soils. Lehr soils are on the tops and upper sides of the ridges and knolls. Spottswood soils are in low areas.

Runoff is medium, and there is a moderate hazard of erosion. This Bowdle soil is somewhat droughty because it is underlain by sand and gravel. Controlling erosion and conserving moisture are the chief management needs.

The soil is best suited to early maturing crops. Most of the acreage is cultivated. A few areas are still in native grass and are used for grazing. Capability unit IIIe–6; Silty range site; windbreak group 6.

Bryant Series

The Bryant series consists of deep, well-drained, nearly level to sloping loamy soils on uplands. These soils formed in glacial drift. The native vegetation was mainly tall, mid, and short grasses.

In a representative profile the surface layer is dark grayish-brown loam about 8 inches thick. The subsoil, about 11 inches thick, is grayish-brown clay loam in the upper part and calcareous, light brownish-gray loam in the lower part. The upper part is slightly hard when dry and friable when moist. The underlying material is calcareous, light brownish-gray and yellowish-brown loam.

Bryant soils have moderate content of organic matter and medium fertility. Available water capacity is high, and permeability is moderate.

Most of the acreage is cultivated. A few small areas are still in native grass and are used for grazing.

Representative profile of Bryant loam, 2 to 6 percent slopes, 2,360 feet east and 215 feet north of the southwest corner of sec. 21, T. 123 N., R. 71 W.

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate, fine and medium, granular structure; soft, very friable, slightly plastic; neutral; abrupt, smooth boundary.

B2—8 to 15 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to moderate, fine and medium, subangular blocky; slightly hard, friable, slightly sticky and plastic; few coarse fragments; neutral; abrupt, wavy boundary.

B3ca—15 to 19 inches, light brownish-gray (2.5Y 6/2) loam, olive brown (2.5Y 4/4) moist; weak, medium, prismatic structure; soft, friable, slightly sticky and slightly plastic; few coarse fragments; common medium masses of segregated lime; strong effervescence (17 percent lime); moderately alkaline; clear, smooth boundary.

C1ca—19 to 32 inches, light brownish-gray (2.5Y 6/2) loam, olive brown (2.5Y 4/4) moist; massive; soft, friable, slightly sticky and slightly plastic; few coarse fragments; common coarse masses of segregated lime; violent effervescence (24 percent lime); moderately alkaline; clear, smooth boundary.

C2—32 to 60 inches, yellowish-brown (10YR 5/4) loam, dark brown (10YR 4/3) moist; many, medium, prominent mottles of reddish yellow (7.5YR 7/8) and light gray (10YR 7/1); massive; soft, friable, slightly sticky and slightly plastic; few coarse

fragments; strong effervescence (14 percent lime); moderately alkaline.

Depth to free carbonates ranges from 12 to 27 inches. The A horizon is dark grayish brown or grayish brown. It commonly is loam or silt loam, but in places is light clay loam or light silty clay loam. It ranges from 5 to 8 inches in thickness. The B2 horizon ranges from dark grayish brown to brown. It commonly is clay loam, but in places is loam, silt loam, or silty clay loam. The B2 horizon has prismatic structure that is weak or moderate. It is 6 to 19 inches thick. The B3ca horizon ranges from grayish brown to light yellowish brown in hue of 2.5Y or 10YR. It has common or many segregations of lime and is 4 to 8 inches thick. The C horizon ranges from grayish brown to pale yellow in hue of 2.5Y or 10YR. It is loam, silt loam, light clay loam, or light silty clay loam that commonly is stratified with thin lenses of very fine sand or fine sand. In places loam or clay loam glacial till is at depths of 40 to 60 inches.

Bryant soils are near Grassna and Temvik soils and are similar to Williams soils. They have a thinner A horizon than Grassna soils and are deeper over firm glacial till than Temvik soils. Their B horizon contains more silt and very fine sand than Williams soils.

BrA—Bryant loam, 0 to 2 percent slopes. This nearly level soil is in irregularly shaped areas that range from 40 to 240 acres in size. Slopes are long and smooth.

Included with this soil in mapping are small areas of Grassna, Niobell, Nishon, Noonan, Tally, Tonka, and Williams soils. Grassna soils are in swales. Niobell and Noonan soils are in low areas. Nishon and Tonka soils are in small potholes, most of which are identified on the soil map by a wet spot symbol. Tally and Williams soils are on some of the slight rises.

This Bryant soil has few or no limitations for crops. Runoff is slow. Shortage of moisture occurs in dry years. Conserving moisture is the chief management need.

This soil is well suited to all crops commonly grown in the county. Most of the acreage is cultivated. Capability unit IIc–2; Silty range site; windbreak group 3.

BrB—Bryant loam, 2 to 6 percent slopes. This gently sloping soil is on uplands in irregularly shaped areas that range from 20 to 160 acres in size. Slopes are long and smooth. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Bearden, Grassna, Nishon, Tally, Tonka, and Williams soils. Bearden and Grassna soils are in swales. Nishon and Tonka soils are in small potholes, or low spots, which commonly are identified on the soil map by a wet spot symbol. Tally and Williams soils are on the higher parts of the landscape in places.

Runoff is medium. The risk of erosion and soil blowing is moderate. Controlling erosion and soil blowing is the chief management need.

This soil is well suited to all crops commonly grown in the county. Most of the acreage is cultivated. Capability unit IIe–1; Silty range site; windbreak group 3.

BrC—Bryant loam, 6 to 9 percent slopes. This sloping soil is on ridges and knolls. Areas are irregular in shape and range from 10 to 60 acres in size. Slopes are short and convex. The surface layer is thinner than in the profile described as representative of the series. In some cultivated areas the surface layer and subsoil have been mixed by plowing. Eroded spots are in some cultivated fields.

Included with this soil in mapping are small areas of Tally, Williams, and Zahill soils. Tally and Williams soils are intermingled with Bryant soils. Zahill soils are on the tops of some of the ridges and knolls.

Runoff is medium, and the hazard of erosion is severe. Controlling erosion is the chief management need.

This soil is well suited to all crops commonly grown in the county, but the hazard of erosion limits row crops. Most of the acreage is cultivated. Capability unit IIIe–1; Silty range site; windbreak group 3.

BvA—Bryant loam, sandy substratum, 1 to 3 percent slopes. This nearly level soil is in irregularly shaped areas that range from 20 to 200 acres in size. It is underlain by sand at a depth of 20 to 40 inches, but otherwise its profile is similar to the one described as representative of the series.

Included with this soil in mapping are small areas of Bowdle and Grassna soils. Bowdle soils are intermingled with this Bryant soil. Grassna soils are in low areas. Also included are areas of other Bryant soils.

This Bryant soil has low or moderate available water capacity and is somewhat droughty. Permeability is moderate in the subsoil and rapid in the underlying sand. Runoff is slow. The hazard of soil blowing is moderate. Conserving moisture and controlling soil blowing are the chief management needs.

This soil is best suited to early maturing crops. Most of the acreage is cultivated. Capability unit IIIs–2; Silty range site; windbreak group 6.

BxB—Bryant-Grassna loams, 2 to 6 percent slopes. This mapping unit is about 55 percent Bryant soils, 25 percent Grassna soils, and 20 percent other soils. The landscape is one of many narrow swales interspersed between slight rises. Bryant soils are on the rises, and Grassna soils are in swales. Areas are irregularly shaped and range from 80 to 640 acres in size.

Included with these soils in mapping are small areas of Bearden, Nishon, Tally, and Tonka soils. Bearden soils are in some of the swales. Nishon and Tonka soils are in small potholes, which are identified on the soil map by a wet spot symbol. Tally soils are on the higher parts of the landscape.

Runoff is medium and collects on the Grassna soils. Spring planting and tillage are delayed in some years because of wetness on the Grassna soil, but in most years the additional moisture is beneficial. The hazard of erosion is moderate on the Bryant soil. Controlling erosion is the chief management need.

These soils are well suited to all crops commonly grown in the county. Most of the acreage is cultivated. Capability unit IIe–1; Silty range site; Bryant soil in windbreak group 3; Grassna soil in windbreak group 1.

Cresbard Series

The Cresbard series consists of deep, moderately well drained, nearly level loamy soils in swales on uplands. These soils have a claypan subsoil. They formed in local alluvium and the underlying glacial till. The native vegetation is mainly mid and tall grasses.

In a representative profile the surface layer is dark-gray and dark grayish-brown loam about 10 inches thick. The next layer is grayish-brown clay loam about

6 inches thick. The subsoil, about 16 inches thick, is grayish-brown heavy clay loam. It is very hard when dry and firm when moist. The underlying material is calcareous, light-gray and olive-brown loam.

Cresbard soils have moderate or high content of organic matter and medium fertility. Available water capacity is moderate or high, and permeability is slow or moderately slow.

Much of the acreage is cultivated. Some areas are still in native grass and are used for grazing.

Cresbard soils in Edmunds County are mapped only with Bowbells soils.

Representative profile of Cresbard loam in an area of Bowbells-Cresbard loams, 0 to 2 percent slopes, 570 feet south and 141 feet west of the northeast corner of sec. 36, T. 123 N., R. 69 W.

A11—0 to 5 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate, fine, granular structure; soft, friable; medium acid; clear, smooth boundary.

A-12—5 to 10 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak, fine and medium, prismatic structure parting to moderate, medium, subangular blocky; hard, friable, slightly sticky and slightly plastic; medium acid; abrupt, smooth boundary.

B&A—10 to 16 inches, grayish-brown (10YR 5/2) clay loam (B), very dark grayish brown (10YR 3/2) moist; gray (10YR 5/1) coatings of silt (A) on faces of peds, very dark gray (10YR 3/1) moist; weak, fine and medium, subangular blocky structure parting to moderate, thin and medium, platy; hard, friable, slightly sticky and slightly plastic; slightly acid; abrupt, smooth boundary.

B21t—16 to 22 inches, grayish-brown (10YR 5/2) heavy clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to strong, fine and medium, blocky; very hard, firm, sticky and plastic; shiny films on faces of blocks; neutral; clear, smooth boundary.

B22t—22 to 32 inches, grayish-brown (2.5Y 5/2) heavy clay loam, very dark grayish brown (2.5Y 3/2) moist; weak, medium, prismatic structure parting to strong, fine and medium, blocky; very hard, firm, sticky and plastic; shiny films on faces of blocks; mildly alkaline; abrupt, wavy boundary.

C1ca—32 to 36 inches, light-gray (2.5Y 7/2) loam, grayish brown (2.5Y 5/2) moist; weak, very coarse, prismatic structure; hard, friable, slightly sticky and plastic; few fine segregations of salts; many fine segregations of lime; violent effervescence; strongly alkaline; clear, wavy boundary.

C2—36 to 60 inches, light olive-brown (2.5Y 5/4) loam stratified with thin lenses of fine sand and silt, olive brown (2.5Y 4/4) moist; common, medium, distinct mottles of light gray (10YR 7/1) and brownish yellow (10YR 6/8); massive; hard, friable, slightly sticky and slightly plastic; few fine segregations of lime; strong effervescence; moderately alkaline.

Depth to free carbonates ranges from 20 to 35 inches. The A horizon commonly is loam, but it is silt loam in places. It ranges from 5 to 10 inches in thickness. The B&A horizon is 3 to 6 inches thick. Reaction in the A and B&A horizons is medium acid to neutral. The B2t horizon is dark grayish-brown to light yellowish-brown heavy clay loam or clay. It has weak or moderate, medium or coarse, prismatic structure that parts to moderate or strong blocky. It is 12 to 22 inches thick. Some pedons have a B3ca horizon. The C horizon ranges from grayish brown to pale yellow in hue of 2.5Y or 5Y. In places the C horizon lacks segregations of gypsum and other salts.

Cresbard soils are mapped with Bowbells soils and are similar to Niobell soils. They contain more clay in the B horizon than both of those soils. They also contain more sodium in the B or C horizon than Bowbells soils.

Divide Series

The Divide series consists of moderately well drained to somewhat poorly drained, nearly level, calcareous loamy soils on uplands. These soils are moderately deep over sand and gravel. They formed in loamy alluvium. The native vegetation was mainly mid and tall grasses.

In a representative profile the surface layer is dark-gray loam about 14 inches thick. The underlying material to a depth of 30 inches is light brownish-gray and light yellowish-brown loam. Below this is pale-brown gravelly clay loam about 4 inches thick. Brown sand and gravel is at a depth of 34 inches.

Divide soils have moderate or high content of organic matter and medium fertility. Available water capacity is low or moderate, and permeability is moderate to a depth of 34 inches and rapid in the underlying sand and gravel. Depth to a seasonal water table ranges from 3 to 5 feet.

Most of the acreage is cultivated. A few small areas are still in native grass and are used for grazing.

Representative profile of Divide loam, 1,585 feet north and 66 feet west of the southeast corner of sec. 31, T. 123 N., R. 73 W.

A11—0 to 5 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, fine and very fine, granular structure; soft, very friable; slight effervescence; mildly alkaline; clear, smooth boundary.

A12—5 to 14 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, medium, prismatic structure parting to weak, fine and medium, subangular blocky; soft, friable; strong effervescence; moderately alkaline; clear, smooth boundary.

C1ca—14 to 24 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable; violent effervescence; strongly alkaline; clear, smooth boundary.

C2ca—24 to 30 inches, light yellowish-brown (2.5Y 6/4) loam, light olive brown (2.5Y 5/4) moist; common, fine, distinct mottles of gray (5Y 6/1) moist; massive; hard, friable; common medium segregations of lime; strong effervescence; moderately alkaline; clear, smooth boundary.

C3—30 to 34 inches, pale-brown (10YR 6/3) gravelly clay loam, dark brown (10YR 4/3) moist; common, fine, distinct mottles of dark yellowish brown (10YR 3/4) moist and few, fine, distinct mottles of gray (5Y 6/1) moist; massive; hard, firm; few medium segregations of lime; slight effervescence; moderately alkaline; abrupt, smooth boundary.

IIC4—34 to 60 inches, brown (10YR 5/3) sand and gravel, dark brown (10YR 3/3) moist; single grained; loose; slight effervescence; moderately alkaline.

Depth to sand and gravel ranges from 20 to 40 inches. The A horizon is dark gray or gray and commonly is loam, but it is silt loam in places. It is 7 to 16 inches thick. The C horizon above the sand and gravel ranges from grayish brown to light yellowish brown. Calcium carbonate equivalent in the C1ca horizon is 15 to 45 percent. Mottles in the C2 and C3 horizons range from few to many and are faint or distinct.

Divide soils lack a B2 horizon and are more calcareous than the nearby Bowdle and Spottswood soils. They also are more poorly drained than Bowdle soils.

Dv—Divide loam. This nearly level soil is along drainageways on uplands. Areas are irregular in shape and range from 10 to 40 acres in size. Slopes are 0 to 2 percent and are smooth.

Included with this soil in mapping are small areas of Bowdle and Spottswood soils on very slight rises. Also included in some areas is a soil that is deeper over sand and gravel than Divide soils.

This Divide soil is high in lime content. It is moderately susceptible to soil blowing. Runoff is slow. Wetness from a water table delays fieldwork early in the growing season in some years, but the water table recedes during the summer. In dry years this soil is droughty because of the underlying sand and gravel. Controlling soil blowing and conserving moisture are the chief management needs.

This soil is suited to all crops commonly grown in the county, but in dry years it is best suited to early maturing crops. Most of the acreage is cultivated. Capability unit IIIs–4; Silty range site; windbreak group 1.

Edgeley Series

The Edgeley series consists of moderately deep, well drained, sloping to moderately steep loamy soils on uplands. These soils formed in a thin layer of glacial till that is underlain by shale. The native vegetation is mainly mid and short grasses.

In a representative profile the surface layer is dark-gray loam about 5 inches thick. The subsoil, about 15 inches thick, is dark grayish-brown loam in the upper part and grayish-brown clay loam in the lower part. The underlying material to a depth of 34 inches is light brownish-gray and gray shaly clay loam. Below this is gray bedded shale.

Edgeley soils have moderate content of organic matter and medium fertility. Available water capacity is low or moderate, and permeability is moderate in the subsoil and slow in the underlying material.

A few areas are cultivated. Most of the acreage is still in native grass and is used for hay and grazing.

Representative profile of Edgeley loam, 6 to 20 percent slopes, 2,613 feet north and 200 feet west of the southeast corner of sec. 4, T. 122 N., R. 66 W.

A1—0 to 5 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate, fine and medium, granular structure; soft, friable, slightly sticky and slightly plastic; slightly acid; clear, smooth boundary.

B21—5 to 10 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak, medium, prismatic structure parting to moderate, medium, subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; slightly acid; clear, smooth boundary.

B22—10 to 15 inches, grayish-brown (2.5Y 5/2) light clay loam, very dark grayish brown (2.5Y 3/2) moist; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; hard, friable, sticky and plastic; mildly alkaline; clear, wavy boundary.

B3—15 to 20 inches, grayish-brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 3/2) crushing to dark grayish brown (2.5Y 4/2) moist; weak, medium, prismatic structure; slightly hard, friable, sticky and plastic; about 25 percent chips and fragments of soft shale; mildly alkaline; clear, wavy boundary.

IIC1—20 to 34 inches, light brownish-gray (2.5Y 6/2) and gray (5Y 6/1) shaly clay loam, dark grayish brown (2.5Y 4/2) and dark gray (5Y 4/1) moist; massive, faint horizontal bedding planes; slightly hard, friable, sticky and plastic; common yellowish-brown (10YR 5/4) stains, dark yellowish brown (10YR 3/4) moist; about 60 percent fine chips and fragments of soft shale; moderately alkaline; abrupt wavy boundary.

IIC2—34 to 60 inches, gray (5Y 6/1) and (5Y 5/1) bedded platy shale, dark gray (5Y 4/1) and very dark gray (5Y 3/1) moist; olive (5Y 6/4) stains on shale plates; slight effervescence; moderately alkaline.

Depth to bedded soft shale ranges from 20 to 40 inches. The soil commonly is noncalcareous, but in places carbonates are in the lower part of the B horizon or in the upper part of the C horizon or both. Reaction is slightly acid or neutral in the A horizon and upper part of the B horizon. The A horizon is 4 to 9 inches thick. The B2 horizon is 7 to 20 inches thick. Some pedons lack a B3 horizon. The IIC1 horizon is 35 to 65 percent shale fragments, by volume.

Edgeley soils are shallower to soft bedded shale than the nearby Vida and Williams soils.

EdE—Edgeley loam, 6 to 20 percent slopes. This sloping to moderately steep soil is on the valley sides of deeply entrenched drainageways in the eastern part of the county. Areas are long and narrow in shape and range from 10 to 80 acres in size. Slopes are short and convex. In places stones and boulders are scattered on the surface on the higher part of the landscape.

Included with this soil in mapping are small areas of Bowbells, Vida, Williams, and Zahill soils. Bowbells and Williams soils are on the lower part of the landscape, and Vida and Zahill soils are on the higher part.

Runoff is medium, and the hazard of erosion is severe. In cultivated areas, controlling erosion is the chief management need. In many areas this soil is too steep or the slopes are too irregular for cultivation.

Most of the acreage is still in native grass and is used for grazing. A few areas are cultivated. Capability unit VIe–1; Silty range site; windbreak group 10.

Grassna Series

The Grassna series consists of deep, moderately well drained, nearly level to gently sloping loamy soils in swales on uplands. These soils formed in glacial drift. The native vegetation was mainly tall and mid grasses.

In a representative profile the surface layer is dark grayish-brown loam about 13 inches thick. The subsoil, about 12 inches thick, is loam that is grayish brown in the upper part and light olive brown in the lower part. The upper part is hard when dry and friable when moist. The underlying material is calcareous, light brownish-gray and grayish-brown loam.

Grassna soils have high content of organic matter and high fertility. Available water capacity is high, and permeability is moderate.

Almost all of the acreage is cultivated.

Representative profile of Grassna loam, 138 feet north and 264 feet west of the southeast corner of sec. 21, T. 124 N., R. 73 W.

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak, fine and medium, granular structure; soft, very friable; neutral; abrupt, smooth boundary.

A12—7 to 13 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak, medium, prismatic structure parting to weak, medium, subangular blocky; slightly hard, friable; neutral; clear, smooth boundary.

B21—13 to 21 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, fine and medium, prismatic structure parting to

moderate, medium, subangular blocky; hard, friable; neutral; abrupt, smooth boundary.

B22—21 to 25 inches, light olive-brown (2.5Y 5/4) loam, very dark grayish brown (2.5Y 3/2) moist; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; slightly hard, friable; mildly alkaline; abrupt, wavy boundary.

C1ca—25 to 35 inches, light brownish-gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; weak, fine and medium, subangular blocky structure; slightly hard, very friable; few fine segregations of lime; strong effervescence; mildly alkaline; clear, wavy boundary.

C2—35 to 60 inches, grayish-brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) moist; common, fine and medium, distinct mottles of light gray (10YR 7/1) and yellowish brown (10YR 5/6); massive, slightly hard, very friable; strong effervescence; moderately alkaline.

Depth to free carbonates ranges from 22 to 40 inches. The A horizon commonly is loam but in places is silt loam or light clay loam. It is 10 to 16 inches thick. The B2 horizon is dark grayish-brown to light olive-brown loam or light clay loam that is less than 15 percent fine or coarser sand. It is 12 to 24 inches thick. Some pedons have a B3 horizon. Segregations of lime in the B3ca and Cca horizons are few or common and fine or medium. Some pedons lack mottles in the C horizon.

Grassna soils are similar to Bowbells soils and are near Bryant soils. They contain more silt and very fine sand in the B horizon than Bowbells soils. They have a thicker A horizon than Bryant soils.

Gr—Grassna loam. This nearly level soil is in swales on uplands. Areas are long and narrow in shape and range from 5 to 50 acres in size. Slopes are 0 to 3 percent and are smooth and slightly concave. This soil has the profile described as representative of the series, but in a few places it is deeper to lime.

Included with this soil in mapping are small areas of Bearden and Tonka soils. Bearden soils are adjacent to small potholes. Tonka soils are in potholes, which are identified on the soil map by a wet spot symbol.

Runoff is slow. In some years, fieldwork is delayed because of runoff from adjacent soils, but in most years the additional moisture is beneficial. This soil has few or no limitations for crops. Shortage of moisture occurs in dry years. Conserving moisture is the chief management need.

This soil is well suited to all crops grown in the county. Most of the acreage is cultivated. Capability unit IIc–3; Overflow range site; windbreak group 1.

Harriet Series

The Harriet series consists of deep, poorly drained, nearly level soils on bottom land. These soils have a claypan subsoil. They formed in alluvium. The native vegetation is mainly salt-tolerant mid and short grasses.

In a representative profile the surface layer is gray silt loam about 4 inches thick. The subsoil, about 16 inches thick, is dark-gray silty clay loam in the upper part, dark-gray silty clay in the middle part, and gray clay in the lower part. It is very hard when dry and very firm when moist. The lower part of the subsoil has spots and streaks of salts that extend into the underlying material. The underlying material to a depth of 35 inches is calcareous, gray silty clay loam. Below this, it is calcareous, grayish-brown and light brownish-gray clay loam.

Harriet soils have moderate content of organic matter and low or medium fertility. Available water capacity is moderate, and permeability is slow. Most areas are subject to occasional flooding. Depth to a seasonal water table is less than 4 feet in most years.

Most of the acreage is still in native grass and is used for hay and grazing.

In Edmunds County, Harriet soils are mapped only in complex with Ranslo soils.

Representative profile of Harriet silt loam in an area of Ranslo-Harriet silt loams, 1,215 feet west and 126 feet south of the northeast corner of sec. 35, T. 122 N., R. 68 W.

A2—0 to 4 inches, gray (10YR 5/1) silt loam, black (10YR 2/1) moist; moderate, medium, subangular blocky structure parting to moderate, thin and medium platy; slightly hard, friable, slightly sticky and slightly plastic; neutral; abrupt, smooth boundary.

B21t—4 to 8 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; strong, very coarse columnar structure; very hard, very firm, sticky, plastic; coatings of gray (10YR 5/1) on column tops; mildly alkaline; clear, smooth boundary.

B22t—8 to 12 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) moist; moderate, medium, prismatic structure parting to moderate, medium blocky; very hard, very firm, sticky and plastic; few fine segregations of salts; moderately alkaline; abrupt, smooth boundary.

B23t—12 to 20 inches, gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; very hard, very firm, sticky and plastic; few fine segregations of gypsum and other salts; strong effervescence; strongly alkaline; abrupt, wavy boundary.

C1gca—20 to 35 inches, gray (5Y 6/1) silty clay loam, dark gray (5Y 4/1) moist; common, fine, prominent mottles of brownish yellow (10YR 6/6); weak, coarse, prismatic structure; hard, firm, sticky and plastic; common medium stains and streaks of very dark gray (10YR 3/1) moist; few fine masses and striations of salts; violent effervescence; strongly alkaline; clear, smooth boundary.

C2gca—35 to 50 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 3/2) moist; common, fine, distinct mottles of brownish yellow (10YR 6/6); massive; hard, friable, slightly sticky and slightly plastic; common fine segregations of salt and lime; violent effervescence; strongly alkaline; clear, smooth boundary.

C3g—50 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; few, fine, distinct mottles of brownish yellow (10YR 6/6); massive; hard, friable, slightly sticky and slightly plastic; many fine and medium segregations of salt and lime; strong effervescence; strongly alkaline.

Depth to free carbonates and segregations of salts ranges from 6 to 16 inches. Some pedons have a thin A1 horizon of silt loam about 1 or 2 inches thick. The A2 horizon is silt loam or loam and is 1 to 5 inches thick. The B2t horizon ranges from dark gray to grayish brown in hue of 10YR or 2.5Y. It ranges from silty clay loam to clay. The B21t horizon has moderate or strong, medium to very coarse, columnar structure. The B22t and B23t horizons have weak or moderate structure. Some pedons have a B3 horizon. The C horizon ranges from gray to light yellowish brown in hue of 2.5Y or 5Y. In places it is stratified with coarser or finer textures below a depth of 40 inches. Some pedons have buried A horizons below a depth of 30 inches.

Harriet soils are mapped with Ranslo soils and are similar to Heil and Miranda soils. They have a thinner A horizon and are more poorly drained than Ranslo soils. They have free carbonates and segregations of salts at shallower depths than Heil soils. They are more poorly drained than Miranda soils.

Heil Series

The Heil series consists of deep, poorly-drained, level silty soils in closed depressions on uplands. These soils have a claypan subsoil. They formed in local alluvium. The native vegetation is mainly mid grasses.

In a representative profile the surface layer is gray silt loam about 2 inches thick. The subsoil, about 33 inches thick, is gray clay in the upper part, gray silty clay in the middle part, and gray clay loam in the lower part. The upper part is very hard when dry, very firm when moist, and very sticky and very plastic when wet. The lower part is calcareous and contains spots and streaks of lime and salts which extend into the underlying material. The underlying material is calcareous, gray clay loam.

Heil soils have moderate content of organic matter and low or medium fertility. Available water capacity is low or moderate, and permeability is very slow.

Most of the acreage is still in native grass and is used for hay and grazing.

Representative profile of Heil silt loam, 650 feet south and 285 feet east of northwest corner of sec. 3, T. 123 N., R. 66 W.

A2—0 to 2 inches, gray (10YR 6/1) silt loam, very dark gray (10YR 3/1) moist; weak, fine, subangular blocky structure parting to weak, very thin, platy; soft, very friable, slightly sticky and slightly plastic; neutral; abrupt, smooth boundary.

B21t—2 to 7 inches, gray (10YR 5/1) clay, very dark gray (10YR 3/1) moist; strong, medium and coarse, columnar structure parting to strong, medium, blocky; very hard, very firm, very sticky and very plastic; shiny films coat faces of blocks; neutral; clear, smooth boundary.

B22—7 to 14 inches, gray (2.5Y 5/1) clay, very dark gray (2.5Y 3/1) moist; coarse, prismatic structure parting to strong, medium and coarse, blocky; very hard, very firm, very sticky and very plastic; shiny films coat faces of blocks; moderately alkaline; abrupt, wavy boundary.

B23t—14 to 25 inches, gray (2.5Y 5/1) silty clay, very dark gray (2.5Y 3/1) moist; moderate, coarse, prismatic structure parting to strong, fine and very fine, blocky; hard, firm, sticky and plastic; shiny films coat faces of blocks; common fine nests of gypsum; moderately alkaline; abrupt, wavy boundary.

B3g—25 to 35 inches, gray (5Y 5/1) clay loam, very dark gray (5Y 3/1) moist; common, fine, distinct mottles of reddish yellow (7.5YR 6/8); weak, very coarse, prismatic structure parting to weak, medium, subangular, blocky; hard, friable, sticky and plastic; few fine nests of gypsum crystals; common fine segregations of lime; strong effervescence; strongly alkaline; clear, smooth boundary.

C1g—35 to 50 inches, gray (5Y 6/1) clay loam, dark gray (5Y 4/1) moist; common, fine, distinct mottles of reddish yellow (7.5YR 6/8); massive, hard, friable, sticky and plastic; few fine nests of gypsum crystals; common fine segregations of lime; strong effervescence; strongly alkaline; clear, smooth boundary.

C2g—50 to 60 inches, gray (5Y 6/1) clay loam, dark gray (5Y 4/1) moist; many, medium, distinct mottles of reddish yellow (7.5YR 6/8); massive; hard, friable, sticky and plastic; few fine nests of gypsum crystals; few fine segregations of lime; strong effervescence; strongly alkaline.

Depth to free carbonates ranges from 15 to 30 inches. Some pedons have a thin A1 horizon about 1 or 2 inches thick, but the combined thickness of the A1 and A2 horizons does not exceed 4 inches. The A2 horizon is gray or light gray and commonly is silt loam, but in places is silty clay loam. It is 1 to 4 inches thick. The B21t horizon ranges from dark gray to grayish brown. It has moderate or strong columnar structure that parts to moderate or strong, fine or medium, blocky. The C horizon is silty clay loam, clay loam, or clay and has few to many, faint to prominent mottles. In places it is stratified with thin lenses of silt and sand. Some pedons are underlain by glacial till at a depth of 40 inches or more. Reaction in the B3 and C horizons is moderately alkaline in some pedons.

Heil soils in (Mh) Mondamin-Heil silty clay loams are better drained than is typical for the series, but this difference does not alter their usefulness and behavior.

Heil soils are similar to Harriet soils and are mapped with Mondamin soils. They commonly are in depressions as are Nishon, Parnell, and Tonka soils. Heil soils are deeper to lime and have segregations of salts at greater depths than Harriet soils. They contain more sodium in the B or C horizons and are more poorly drained than Mondamin soils. They have thinner A horizons and more sodium in the B or C horizons than Nishon, Parnell, and Tonka soils.

He—Heil silt loam. This level soil is in shallow, closed depressions on uplands. Areas are circular to long and narrow in shape and from 5 to 80 acres in size. Slopes are 0 to 1 percent.

Included with this soil in mapping are small areas of Nishon, Parnell, and Tonka soils. These included soils are in the lower part of some depressions.

Runoff is ponded, and water remains on the surface until it evaporates. This Heil soil takes in water very slowly, and the dense claypan subsoil releases it slowly to plants. Tilth is very poor. This soil is not suited to cultivation.

Most of the acreage is still in native grass and is used for hay or grazing. Capability unit VIs–1; Closed Depression range site; windbreak group 10.

Lehr Series

The Lehr series consists of well drained to somewhat excessively drained, nearly level to gently undulating loamy soils on uplands. These soils are shallow to sand and gravel. They formed in alluvium. The native vegetation was mainly mid and short grasses.

In a representative profile the surface layer is dark grayish-brown loam about 6 inches thick. The subsoil, about 10 inches thick, is dark grayish-brown loam in the upper part and calcareous, grayish-brown sandy loam in the lower part. The upper part is hard when dry and friable when moist. Below a depth of 16 inches is calcareous, light-gray and light-brownish-gray sand and gravel.

Lehr soils have moderate content of organic matter and low fertility. Available water capacity is low, and permeability is moderately rapid in the subsoil and rapid in the underlying sand and gravel.

Most of the acreage is cultivated. A few areas are still in native grass and are used for grazing.

Representative profile of Lehr loam, 3 to 6 percent slopes, 2,112 feet east and 100 feet north of the southwest corner of sec. 32, T. 123 N., R. 73 W.

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate, very fine, granular structure; slightly hard, friable; neutral; abrupt, smooth boundary.

B2—6 to 12 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure parting to moderate, medium, subangular blocky; hard, friable; neutral; clear, smooth boundary.

B3—12 to 16 inches, grayish-brown (10YR 5/2) sandy

loam, dark grayish brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) moist; weak, medium and fine, subangular blocky structure; slightly hard, very friable; 10 percent fine gravel; slight effervescence; mildly alkaline; clear, wavy boundary.

IIC1—16 to 42 inches, light-gray (2.5Y 7/2) and light brownish-gray (2.5Y 6/2) sand and gravel, dark grayish brown (2.5Y 4/2) moist; single grained; loose; strong effervescence; mildly alkaline; abrupt, smooth boundary.

IIC2—42 to 60 inches, light brownish-gray (2.5Y 6/2) fine sand, dark grayish brown (2.5Y 4/2) moist; single grained; loose; strong effervescence; mildly alkaline.

Depth to sand and gravel ranges from 10 to 20 inches. The A horizon commonly is loam, but in places it is fine sandy loam. It is 5 to 8 inches thick. The B2 horizon is dark grayish-brown to light brownish-gray loam or light clay loam. It has weak or moderate, medium or coarse, prismatic structure that parts to weak or moderate, subangular blocky. The B2 horizon is 5 to 12 inches thick. Some pedons lack a B3 horizon. The sand and gravel in the IIC horizon is stratified and well sorted to poorly sorted.

Lehr soils are near Bowdle and Wabek soils. They are shallower to sand and gravel than Bowdle soils. They are deeper to sand and gravel than Wabek soils.

LeA—Lehr loam, 0 to 3 percent slopes. This nearly level soil is on uplands. Areas are irregular in shape and range from 15 to 160 acres in size. Slopes are long and smooth. This soil has a thicker surface layer than that in the profile described as representative of the series.

Included with this soil in mapping are small areas of Bowdle, Divide, Spottswood, and Wabek soils. Bowdle, Divide, and Spottswood soils are in low spots. Wabek soils are on slight rises.

This Lehr soil is droughty because of the underlying sand and gravel. It is moderately susceptible to soil blowing. Runoff is slow. Conserving moisture and controlling soil blowing are the chief management needs.

This soil is best suited for early maturing small grain. Most of the acreage is cultivated. Capability unit IVs–1; Shallow to Gravel range site; windbreak group 10.

LeB—Lehr loam, 3 to 6 percent slopes. This gently sloping soil is on uplands. Areas are irregular in shape and range from 10 to 120 acres in size. Slopes are long and smooth. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Bowdle, Divide, Spottswood, and Wabek soils. Bowdle soils are on the lower part of the landscape. Divide and Spottswood soils are in swales. Wabek soils are on the tops of ridges and knolls.

This Lehr soil is subject to erosion and soil blowing. It also is droughty because of the sand and gravel at shallow depths. Runoff is medium. Controlling erosion and soil blowing and conserving moisture are the chief management needs.

This soil is best suited to early maturing small grain. Most of the acreage is cultivated. A few areas are still in native grass and are used for grazing. Capability unit IVe–6; Shallow to Gravel range site; windbreak group 10.

LhB—Lehr-Bowdle loams, 0 to 6 percent slopes. This mapping unit is about 50 percent Lehr soils, 30 percent Bowdle soils, and 20 percent other soils. Areas are irregular in shape and range from 20 to 400 acres in size. The soils are nearly level to gently undulating. Slopes are short and convex. In places stones are scattered on the surface on the higher parts of the landscape. The Lehr soil is in the higher part. The Bowdle soil has a thinner surface layer than that in the profile described as representative of the series. It is in the lower part of the landscape and in swales.

Included with these soils in mapping are small areas of Bryant and Wabek soils. Bryant soils are in the low areas. Wabek soils are on the tops of the low ridges and knolls.

Runoff is slow to medium. These soils are moderately susceptible to erosion and soil blowing. They also are droughty because of the underlying sand and gravel. Controlling erosion and soil blowing and conserving moisture are the chief management needs.

These soils are best suited to early maturing small grain. Most of the acreage is cultivated. A few areas are still in native grass and are used for grazing. Capability unit IVe–6; Lehr soil in Shallow to Gravel range site, windbreak group 10; Bowdle soil in Silty range site, windbreak group 6.

Letcher Series

The Letcher series consists of deep, moderately well drained to somewhat poorly drained, nearly level loamy soils on uplands. These soils formed in glacial outwash. The native vegetation was mainly mid and tall grasses.

In a representative profile the surface layer is dark-gray fine sandy loam and sandy loam about 12 inches thick. The subsurface layer is light brownish-gray sandy loam about 3 inches thick. The subsoil, about 10 inches thick, is dark grayish-brown sandy loam. The upper part is extremely hard when dry and firm when moist. The lower part is calcareous and contains spots and streaks of lime and salts, which extend into the underlying material. The underlying material to a depth of 32 inches is calcareous, grayish-brown sandy loam. Below this, it is calcareous, gray loam and dark-gray and light brownish-gray sandy loam.

Letcher soils have moderate content of organic matter and medium fertility. Available water capacity is low or moderate, and permeability is slow in the subsoil and moderately rapid in the underlying material. Depth to a seasonal water table ranges from 4 to 6 feet.

Most areas are still in native grass and are used for hay or grazing.

Representative profile of Letcher fine sandy loam, 285 feet west and 120 feet north of the southeast corner of sec. 6, T. 124 N., R. 66 W.

A11—0 to 8 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak, fine and medium, subangular blocky structure parting to very weak, fine and medium, granular; slightly hard, very friable; strongly acid; clear, smooth boundary.

A12—8 to 12 inches, dark-gray (10YR 4/1) sandy loam, black (10YR 2/1) moist; weak, medium and coarse, subangular blocky structure parting to very weak, fine and medium, granular; slightly hard, very friable; medium acid; abrupt, smooth boundary.

A2—12 to 15 inches, light brownish-gray (10YR 6/2) sandy loam, very dark grayish brown (10YR 3/2) moist; few, fine, faint mottles of yellowish brown (10YR 5/6); weak, fine and medium, subangular blocky structure parting to weak, very thin, platy; slightly hard, very friable; neutral; clear, wavy boundary.

B2t—15 to 19 inches, dark grayish-brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2)

moist; strong, very coarse, columnar structure; extremely hard, firm; light brownish-gray (10YR 6/2) coatings on tops of columns; neutral; clear, smooth boundary.

B3ca—19 to 25 inches, dark grayish-brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak, very coarse, prismatic structure; hard very friable; few fine segregations of salt and lime; slight effervescence; strongly alkaline; clear, smooth boundary.

C1—25 to 32 inches, grayish-brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; massive; hard, very friable; few fine masses and striations of salt and lime; slight effervescence; strongly alkaline; abrupt, smooth boundary.

Ab1—32 to 40 inches, gray (10YR 5/1) loam, very dark gray (10YR 3/1) moist; massive; very hard, firm; few fine masses and striations of lime; slight effervescence; strongly alkaline; abrupt, smooth boundary.

Ab2—40 to 48 inches, dark-gray (10YR 4/1) sandy loam, black (10YR 2/1) moist; massive; very hard, friable; many fine masses and striations of lime; strong effervescence; strongly alkaline; abrupt, smooth boundary.

C2—48 to 60 inches, light brownish-gray (2.5Y 6/2) and light-gray (2.5Y 7/2) sandy loam, dark grayish brown (10YR 4/2) moist; common, fine, faint mottles of reddish yellow (7.5YR 6/8) moist; massive; hard, friable; strong effervescence; strongly alkaline.

The solum is 15 to 30 inches thick. The A1 horizon is dark gray or gray and commonly is fine sandy loam or sandy loam, but in places it is loam. It is 5 to 14 inches thick. The A2 horizon is gray, light gray, or light brownish gray. It commonly is sandy loam, but in places it is fine sandy loam or loamy fine sand. It is 1 to 5 inches thick. The B2t horizon ranges from dark grayish brown to brown or light olive brown in hue of 10YR or 2.5Y. It is sandy loam or fine sandy loam and has strong or moderate, coarse or very coarse, columnar structure. Some pedons lack a buried A horizon.

Letcher soils are similar to Noonan soils. They contain more sand and less clay in the B2t horizon than Noonan soils.

Lt—Letcher fine sandy loam. This nearly level soil is along drainageways on uplands. Areas are irregular in shape and range from 20 to 160 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are small areas of Miranda, Niobell, Noonan, Tally, and Williams soils. Miranda, Niobell, and Noonan soils are at the edge of the mapped areas. Tally and Williams soils are on knolls or slight rises.

This Letcher soil is highly susceptible to soil blowing. Runoff is slow. The subsoil takes in water slowly and releases it slowly to plants. Sodium and other salts in the subsoil or underlying material limit crop growth. If this soil is cultivated, controlling soil blowing is the chief management need.

A few areas of this soil are cultivated. Most areas are still in native grass and are used for hay or grazing. Capability unit IVe–13; Sandy range site; windbreak group 5.

Loamy Fluvaquents

Loamy Fluvaquents consist of deep, mostly somewhat poorly drained, nearly level loamy soils on bottom land. These soils formed in stratified loamy alluvium.

The surface layer commonly is loam or silt loam and is underlain by stratified loamy and silty sediments that generally are loam but range from fine sandy loam to clay loam. In places these soils are underlain by sand and gravel. Some of the soils are calcareous at or near the surface, but some are noncalcareous.

Loamy Fluvaquents have medium to high fertility. Available water capacity is high. Soil areas are subject to flooding, and a seasonal water table occurs in some areas.

Lv—Loamy Fluvaquents. These mixed alluvial soils are on bottom land along small creeks and drainageways. Areas are long and narrow in shape and range from 40 to 320 acres in size. They commonly are dissected by channels that meander from one side of the flood plain to the other. Slopes are 0 to 2 percent.

Included with these soils in mapping are small areas of Bowbells and Grassna soils in places where swales and tributary drainageways merge into mapped areas of these soils.

These soils are subject to flooding following rapid snowmelt or heavy rains. Runoff is slow. Wetness from flooding or a seasonal water table and the presence of meandering channels limit the use of these soils.

Most of the acreage is still native grass and is used for hay or grazing. Stringers and clumps of native trees and shrubs along the channels provide habitat for wildlife. Capability unit VIw–3; Overflow range site; windbreak group 10.

Marsh

Mb—Marsh. This land type consists of areas that are covered by shallow water during the growing season in most years. Most of the areas contain open water that seldom is more than 3 feet deep. Areas of Marsh range from 50 to 240 acres in size. Slopes are 0 to 1 percent.

Marsh is used primarily as habitat for wildlife. Coarse aquatic plants grow on the edges of the areas or throughout. Capability unit VIIIw–1; not assigned to a range site or windbreak group.

Miranda Series

The Miranda series consists of deep, moderately well drained to somewhat poorly drained, nearly level loamy soils on uplands. These soils have a claypan subsoil. They formed in glacial till. The native vegetation is mainly mid and short grasses.

In a representative profile the surface layer is light brownish-gray loam about 4 inches thick. The subsoil, about 12 inches thick, is clay loam that is grayish brown in the upper part, dark brown in the middle part, and light brownish gray in the lower part. The upper part is extremely hard when dry, very firm when moist, and sticky and plastic when wet. The lower part contains spots and streaks of salt, which extend into the underlying material. The underlying material is calcareous light brownish-gray and pale-yellow clay loam.

Miranda soils have moderate content of organic matter and low fertility. Available water capacity is moderate or high, but permeability is very slow.

Many areas are cultivated. Some areas are still in native grass and are used for hay and grazing.

In Edmunds County, Miranda soils are mapped only with Niobell soils.

Representative profile of Miranda loam in an area of Niobell-Miranda loams, 0 to 3 percent slopes, 264 feet south and 90 feet west of the northeast corner of sec. 22, T. 124 N., R. 66 W.

A2—0 to 4 inches, light brownish-gray (10YR 6/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, subangular structure parting to weak, thin, platy; hard, friable; neutral; abrupt, smooth boundary.

B21t—4 to 7 inches, grayish-brown (10YR 5/2) clay loam, very dark brown (10YR 2/2) moist; strong, fine and medium, columnar structure; extremely hard, very firm, sticky and plastic; light brownish-gray (10YR 6/2) coatings on tops of columns; mildly alkaline; abrupt, smooth boundary.

B22t—7 to 10 inches, dark-brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; moderate, medium, prismatic structure parting to moderate, fine and medium, blocky; very hard, very firm, sticky and plastic; moderately alkaline; clear, wavy boundary.

B3sa—10 to 16 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak, coarse, prismatic structure; hard, firm, sticky and plastic; common fine segregations of salts; strongly alkaline; abrupt, wavy boundary.

C1casa—16 to 30 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; few fine, distinct mottles of strong brown (7.5YR 5/8) moist; hard, firm, sticky and plastic; common fine segregations of lime and salts; strong effervescence; strongly alkaline, clear, smooth boundary.

C2cs—30 to 38 inches, pale-yellow (2.5Y 7/4) clay loam, light olive brown (2.5Y 5/4) moist; few, fine, distinct mottles of strong brown (7.5YR 5/8) moist and common, medium, distinct mottles of light gray (10YR 7/1) moist; massive; hard, firm, sticky and plastic; common fine streaks of salt and gypsum; common medium segregations of lime; strong effervescence; strongly alkaline; clear, smooth boundary.

C3—38 to 60 inches, pale-yellow (2.5Y 7/4) clay loam, light olive brown (2.5Y 5/4) moist; few, fine, distinct mottles of strong brown (7.5YR 5/8) moist and many, fine, distinct mottles of light gray (10YR 7/1) moist; massive; hard, firm, sticky and plastic; few fine streaks of gypsum; common medium segregations of lime; strong effervescence; strongly alkaline.

The solum is 10 to 18 inches thick. Depth to free carbonates ranges from 8 to 20 inches, and depth to segregations of salt or gypsum ranges from 6 to 16 inches. Some pedons have a thin A1 horizon 1 or 2 inches thick. The A2 horizon ranges from gray to light brownish-gray loam or silt loam. It is 2 to 5 inches thick. The B2t horizon ranges from dark grayish brown to brown or light olive brown in hue of 10YR or 2.5Y. In places it is heavy loam. The B21t horizon has columnar structure that is strong or moderate and fine to coarse. The C horizon ranges from grayish brown to pale yellow in hue of 10YR, 2.5Y, or 5Y. In places it is loam.

Miranda soils are mapped with or are near Niobell and Noonan soils. They have a thinner A horizon and contain salts at shallower depths than those soils.

Mondamin Series

The Mondamin series consists of deep, well drained and moderately well drained, nearly level to gently sloping silty soils on uplands. These soils have a clayey subsoil. They formed in lacustrine sediments of glacial, ice-walled lakes. The native vegetation was mainly mid and short grasses.

In a representative profile the surface layer is dark grayish-brown silty clay loam about 6 inches thick. The subsoil is about 15 inches thick. It is dark grayish-brown silty clay in the upper part and calcareous, light brownish-gray and grayish-brown silty clay loam in the lower part. The upper part is very hard when dry and firm when moist. The underlying material is calcareous, light brownish-gray and light-gray silty clay loam.

Mondamin soils have moderate or high content of organic matter and medium fertility. Available water capacity is high, and permeability is moderately slow or slow.

Most of the acreage is cultivated. A few areas are still in native grass and are used for hay or grazing.

Representative profile of Mondamin silty clay loam, 0 to 2 percent slopes, 1,990 feet east and 210 feet north of the southwest corner of sec. 3, T. 122 N., R. 71 W.

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate, fine and medium, granular structure; hard, friable, slightly sticky and slightly plastic; slightly acid; abrupt, smooth boundary.

B2t—6 to 13 inches, dark grayish-brown (10YR 4/2) silty clay, very dark brown (10YR 2/2) moist; weak, medium, prismatic structure parting to moderate, medium and coarse, blocky; very hard, firm, sticky and plastic; neutral; abrupt, wavy boundary.

B31ca—13 to 21 inches, light brownish-gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak, medium, prismatic structure parting to moderate, medium and coarse, blocky and subangular blocky; hard, firm, sticky and plastic; common tongues (¼ to 1 inch wide) of dark grayish brown (10YR 4/2), very dark brown (10YR 2/2) moist; many, very fine striations and masses of segregated lime; strong effervescence; mildly alkaline; clear, wavy boundary.

B32ca—21 to 35 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak, coarse, prismatic structure parting to weak, medium and coarse, subangular blocky; hard, firm, sticky and plastic; few tongues (¼ to ½ inch wide) of dark grayish brown (10YR 4/2), very dark brown (10YR 2/2) moist; common, medium and coarse segregations of lime; strong effervescence; mildly alkaline; gradual, wavy boundary.

C1ca—35 to 43 inches, light brownish-gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; many, fine, distinct mottles of light gray (10YR 7/1) and brownish yellow (10YR 6/6); massive; hard, firm, slightly sticky and slightly plastic; few, fine and medium segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

C2—43 to 55 inches, light-gray (2.5Y 7/2) and light brownish-gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; many, medium, distinct mottles of light gray (10YR 7/1) and brownish yellow (10YR 6/6); massive; slightly hard, very friable, slightly sticky and slightly plastic; thin lenses of very fine sand and fine sand; slight effervescence; moderately alkaline; clear, wavy boundary.

C3—55 to 60 inches, light brownish-gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; common, fine, distinct mottles of light gray (10YR 7/1) and brownish yellow (10YR 6/6); massive; slightly hard, very friable, slightly sticky and slightly plastic; thin lenses of very fine sand and fine sand; common medium masses of gypsum; slight effervescence; moderately alkaline.

The solum is 20 to 44 inches thick. The depth to free carbonates ranges from 12 to 20 inches. The A horizon commonly is silty clay loam, but in places it is silt loam. It is 4 to 8 inches thick. The B2t horizon ranges from dark

grayish brown to brown or light olive brown in hue of 10YR or 2.5Y. It is silty clay or heavy silty clay loam and has weak or moderate, medium or coarse, prismatic structure that parts to moderate or strong blocky. In places the C horizon is loam or clay loam glacial till below a depth of 40 inches. Mottles are few to many and faint or distinct. Dark-colored tongues extend into the C horizon in some pedons.

Mondamin soils have a more clayey B horizon than the nearby Bryant soils.

MdA—Mondamin silty clay loam, 0 to 2 percent slopes. This nearly level soil is on uplands. Areas are irregular in shape and range from 20 to 160 acres in size. Slopes are long and smooth. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Bearden, Bowdle, Bryant, Heil, Tally, and Williams soils. Bearden soils are in low areas near closed depressions. Bowdle, Bryant, Tally, and Williams soils are at the edge of some areas. Heil soils are in shallow closed depressions or low spots.

This Mondamin soil dries slowly in spring. Runoff is slow. The clayey subsoil takes in water slowly and releases it slowly to plants. If the soil is cultivated, tilth deteriorates and the risk of soil blowing is moderate. Improving water intake, maintaining tilth, and controlling soil blowing are the chief management needs.

This soil is well suited to all crops commonly grown in the county. Most of the acreage is cultivated. Capability unit IIs–1; Clayey range site; windbreak group 4.

MdB—Mondamin silty clay loam, 2 to 6 percent slopes. This gently sloping soil is on uplands. Areas are irregular in shape and range from 10 to 80 acres in size. Slopes are long and smooth.

Included with this soil in mapping are small areas of Bearden, Bowdle, Bryant, Vida, and Williams soils. Bearden soils are on the lower parts of the landscape. Bowdle, Bryant, Tally, and Williams soils are at the edge of some areas. Vida soils are on some of the ridgetops.

Runoff is medium. Erosion and soil blowing are moderate hazards. The clayey subsoil takes in water slowly and releases it slowly to plants. Tilth usually deteriorates if the soil is cultivated. Controlling erosion and soil blowing, improving water intake, and maintaining tilth are the chief management needs.

This soil is well suited to all crops commonly grown in the county. Most of the acreage is cultivated. Capability unit IIIe–3; Clayey range site; windbreak group 4.

Mh—Mondamin-Heil silty clay loams. This mapping unit is about 55 percent Mondamin soils, 25 percent Heil soils, and 20 percent other soils. Areas are irregular in shape and range from 20 to 240 acres in size. Slopes are 0 to 2 percent and are long and smooth. The Mondamin soil is on very slight rises. The Heil soil is better drained than the soil described as representative of the series. It is in swales or slight sags. In cultivated areas the surface layer and the subsoil have been mixed by plowing.

Included with these soils in mapping are small areas of Bearden, Bryant, and Nishon soils. Bearden soils are in some of the low areas. Bryant soils are on some of the very slight rises. Nishon soils are in small, closed depressions.

Runoff is slow on the Mondamin soil and very slow on the Heil soil. The Mondamin soil loses tilth if cultivated. The clayey subsoil takes in water slowly. The Heil soil has very poor tilth. The dense claypan subsoil takes in water very slowly, and the sodium content affects crop growth. Controlling soil blowing, improving water intake, and maintaining tilth are the chief management needs.

The Mondamin soil is well suited to all crops commonly grown in the county, but the Heil soil is not suited to crops. Much of the acreage is cultivated, but some areas remain in native grass and are used for grazing or hay. Mondamin soil in capability unit IIs–1, Clayey range site, windbreak group 4; Heil soil in capability unit VIs–1, Thin Claypan range site, windbreak group 10.

Niobell Series

The Niobell series consists of deep, moderately well drained, nearly level to gently sloping loamy soils on uplands. These soils have a claypan subsoil. They formed in glacial till. The native vegetation is mainly mid and short grasses.

In a representative profile the surface layer is dark grayish-brown loam about 6 inches thick. The next layer, about 10 inches thick, is dark-brown and light grayish-brown clay loam. The subsoil, about 14 inches thick, is clay loam that is grayish brown in the upper part, light olive brown in the middle part, and light yellowish brown in the lower part. The upper part is very hard when dry and firm when moist. The lower part is calcareous and has spots and streaks of lime that extend into the underlying material. The underlying material is calcareous, light brownish-gray clay loam.

Niobell soils have moderate content of organic matter and medium fertility. Available water capacity is high, and permeability is slow.

Many areas are cultivated. Some areas are still in native grass and are used for hay and grazing.

Representative profile of Niobell loam in an area of Niobell-Noonan loams, 1 to 5 percent slopes, 538 feet north and 65 feet east of the southwest corner of sec. 20, T. 123 N., R. 66 W.

A1—0 to 6 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate, fine and medium, granular structure; soft, very friable; neutral; clear, smooth boundary.

B&A—6 to 16 inches, dark-brown (10YR 4/3) light clay loam (B), very dark grayish brown (10YR 3/2) moist; light brownish-gray (10YR 6/2) coatings of silt and very fine sand (A) on faces of peds, very dark grayish brown (10YR 3/2) moist; moderate, fine, blocky structure; slightly hard, friable, slightly sticky and plastic; neutral; abrupt, smooth boundary.

B21t—16 to 20 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, fine and medium, prismatic structure parting to strong, medium, blocky; very hard, firm, sticky and plastic; shiny coats on faces of peds; mildly alkaline; abrupt, smooth boundary.

B22t—20 to 26 inches, light olive-brown (2.5Y 5/3) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; very hard, firm, sticky and plastic; shiny coats on faces of peds; mildly alkaline; abrupt, smooth boundary.

B3ca—26 to 30 inches, light yellowish-brown (2.5Y 6/3) clay loam, dark grayish brown (2.5Y 4/2) moist; few, fine, distinct relict mottles of strong brown (7.5YR 5/8); weak, coarse, prismatic structure; hard, firm, sticky and plastic; few fine segregations of lime; slight effervescence; strongly alkaline; clear, smooth boundary.

C1ca—30 to 40 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; few, fine, distinct relict mottles of strong brown (7.5YR 5/8); massive; hard, firm, sticky and plastic; many, medium segregations of lime; strong effervescence; strongly alkaline; gradual, smooth boundary.

C2—40 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; few, medium, distinct relict mottles of gray (5Y 6/1) and few, fine, distinct relict mottles of strong brown (7.5YR 5/8); massive, hard, firm, sticky and plastic; common fine and medium segregations of lime; strong effervescence; strongly alkaline.

Depth to free carbonates ranges from 15 to 32 inches. The A1 horizon is loam or silt loam and is 5 to 10 inches thick. Some pedons have a thin A2 horizon. The B&A horizon is light clay loam or heavy loam and is 4 to 10 inches thick. The B2t horizon ranges from dark grayish brown to light yellowish brown and commonly is clay loam but is heavy loam in some pedons. It is 6 to 12 inches thick. Exchangeable sodium exceeds 15 percent in the lower part of the B horizon or in the C horizon. Relict mottles in the B2 and C horizons are few or common and faint or distinct.

Niobell soils are mapped with Miranda and Noonan soils and are near Williams soils. In contrast with Miranda and Noonan soils, Niobell soils lack columnar structure in the B horizon. They have a thicker A horizon than Miranda soils. Niobell soils contain more sodium in the B or C horizons than Williams soils.

NmA—Niobell-Miranda loams, 0 to 3 percent slopes. This mapping unit is about 40 percent Niobell soils, 30 percent Miranda soils, and 30 percent other soils. Areas are irregular in shape and range from 20 to 80 acres in size. The soils are nearly level and have an uneven surface because there are many small low spots. The Niobell soil is between the low spots and the Miranda soil is in the low spots. This Miranda soil has the profile described as representative of the series.

Included with these soils in mapping are small areas of Bowbells, Heil, Noonan, and Williams soils. Noonan soils are the most extensive and commonly rim the low spots. Bowbells soils are in swales, and Heil soils are in closed depressions. Williams soils are on slight rises.

Wetness delays spring planting in some years. Runoff is slow. These soils take in water slowly or very slowly and release it slowly to plants. The Miranda soil has very poor tilth. Its dense claypan subsoil and sodium content restrict crop growth. Improving water intake and tilth is the chief management need.

The Niobell soil is moderately well suited to most crops, but the Miranda soil is not suited to crops. Much of the acreage is cultivated. Some areas are still in native grass and are used for hay and grazing. Niobell soil in capability unit IIIs–1, Clayey range site, windbreak group 4; Miranda soil in capability unit VIs–1, Thin Claypan range site, windbreak group 10.

NpB—Niobell-Noonan loams, 1 to 5 percent slopes. This mapping unit is about 35 percent Niobell soils, 30 percent Noonan soils, and 35 percent other soils. Areas are irregular in shape and range from 80 to 400 acres in size. The soils are nearly level to gently sloping, and in places they have an uneven surface because there are small low spots. Both soils have the profiles described as representative of their series.

Included with these soils in mapping are small areas of Bowbells, Bryant, Grassna, Heil, Miranda, Tally, and Williams soils. Williams soils are the most extensive. They make up as much as 30 percent of some mapped areas. Bowbells and Grassna soils are in swales. Bryant, Tally, and Williams soils are on the higher part of the landscape. Heil soils are in small closed depressions. Miranda soils are on the lower part adjacent to swales.

Runoff is slow to medium, and the hazard of erosion is moderate. These soils have a claypan subsoil that takes in water slowly and releases it slowly to plants. Controlling erosion and improving water intake into the claypan subsoil are the chief management needs.

These soils are better suited to small grain and alfalfa than to row crops. Much of the acreage is cultivated, but some areas are still in native grass and are used for hay and grazing. Capability unit IIIe–3; Niobell soil in Clayey range site, windbreak group 4; Noonan soil in Claypan range site, windbreak group 9.

Nishon Series

The Nishon series consists of deep, poorly drained, level silty soils in closed depressions on uplands. These soils have a clayey subsoil. They formed in alluvium washed in from adjacent soils. The native vegetation is mainly mid grasses and sedges.

In a representative profile the surface layer is dark-gray silt loam about 4 inches thick. The subsurface layer is light-gray silt loam about 6 inches thick. The subsoil, about 22 inches thick, is gray and grayish-brown clay in the upper part and calcareous, light brownish-gray clay loam in the lower part. The upper part is very hard when dry and very firm when moist. The underlying material is calcareous, light olive-gray clay loam.

Nishon soils have moderately low content of organic matter and medium fertility. Available water capacity is high, and permeability is slow.

Many areas are still in native vegetation and are used for hay or grazing. Some areas are cultivated.

The Nishon soils in Edmunds County are mapped only with Tonka and Williams soils.

Representative profile of Nishon silt loam in an area of Tonka-Nishon silt loams, 270 feet west and 100 feet south of the northeast corner of sec. 21, T. 122 N., R. 66 W.

A1—0 to 4 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; moderate, thin and very thin, platy structure; soft, friable, slightly plastic; neutral; abrupt, wavy boundary.

A2—4 to 10 inches, light-gray (10YR 7/1) silt loam, dark gray (10YR 4/1) moist; common, fine, distinct mottles of reddish yellow (7.5YR 7/6); moderate, very thin and thin, platy structure; soft, friable, slightly plastic; neutral; abrupt, wavy boundary.

B21t—10 to 15 inches, gray (10YR 5/1) clay, very dark gray (10YR 3/1) moist; moderate, medium and coarse, columnar structure parting to strong, fine and medium, blocky; very hard, very firm, very sticky and very plastic; light gray (10YR 7/1) coatings on column tops; shiny surfaces on peds; mildly alkaline; clear, smooth boundary.

B22t—15 to 22 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; few, fine, dis-

tinct mottles of reddish yellow (7.5YR 7/6); moderate, medium, subangular blocky structure; very hard, very firm, very sticky and very plastic; shiny surfaces on peds; mildly alkaline; abrupt, wavy boundary.

B3ca—22 to 32 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; few, fine, distinct mottles of reddish yellow (7.5YR 7/6); weak, medium, subangular blocky structure; hard, firm, sticky and plastic; common fine segregations of lime; violent effervescence; moderately alkaline; clear, wavy boundary.

Cca—32 to 60 inches, light olive-gray (5Y 6/2) clay loam, olive gray (5Y 5/2) moist; many, fine, distinct mottles of reddish yellow (7.5YR 6/8); massive; hard, firm, sticky and plastic; many fine and medium segregations of lime; violent effervescence; moderately alkaline.

The solum is 25 to 45 inches thick. Depth to free carbonates ranges from 16 to 35 inches. The A1 horizon is dark gray to grayish brown and commonly is silt loam but is loam or silty clay loam in places. It ranges to as much as 4 inches in thickness, but some pedons lack an A1 horizon. The A2 horizon is silt loam or loam and is 4 to 7 inches thick. The B2t horizon is dark gray to grayish brown. It commonly is clay, but in places it is silty clay or heavy silty clay loam. Some pedons have prismatic instead of columnar structure in the B21t horizon. The C horizon ranges from gray to light olive gray. Mottles in the B and C horizons are faint to prominent.

Nishon soils are in closed depressions like Parnell and Tonka soils. They are not so poorly drained as Parnell soils and, unlike Parnell soils, have a distinct A2 horizon. Nishon soils have a thinner A1 horizon than Tonka soils.

Noonan Series

The Noonan series consists of deep, moderately well drained, nearly level to gently sloping loamy soils on uplands. These soils have a claypan subsoil. They formed in glacial till. The native vegetation is mainly mid and short grasses.

In a representative profile the surface layer is dark grayish-brown loam about 6 inches thick. The subsurface layer is light brownish-gray loam about 4 inches thick. The subsoil, about 12 inches thick, is clay loam that is dark grayish brown in the upper part and light olive brown in the lower part. The upper part is very hard when dry and firm when moist. The underlying material is calcareous, light brownish-gray clay loam that has spots and streaks of lime and gypsum.

Noonan soils have moderate content of organic matter and low to medium fertility. Available water capacity is high, but permeability is slow.

Many areas are cultivated. Some areas are still in native grass and are used for hay and grazing.

The Noonan soils in Edmunds County are mapped only with Niobell soils.

Representative profile of Noonan loam in an area of Niobell-Noonan loams, 1 to 5 percent slopes, 528 feet north and 65 feet east of the southwest corner of sec. 20, T. 123 N., R. 66 W.

A1—0 to 6 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate, fine and medium, granular structure; soft, very friable, slightly plastic; slightly acid; abrupt, smooth boundary.

A2—6 to 10 inches, light brownish-gray (10YR 6/2) loam, very dark grayish brown (10YR 3/2) moist; weak, medium, subangular blocky structure parting to moderate, fine, subangular blocky and platy; slightly hard, friable, slightly sticky and slightly plastic; neutral; abrupt, smooth boundary.

B21t—10 to 14 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; strong, medium, columnar structure parting to strong, fine, blocky; very hard, firm, sticky and plastic; coatings of light brownish-gray loam on column tops, very dark grayish brown (10YR 3/2) moist; shiny coats on faces of peds; mildly alkaline; clear, smooth boundary.

B22t—14 to 18 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to moderate, fine and medium, blocky; very hard, firm, sticky and plastic; shiny coats on faces of peds; moderately alkaline; abrupt, wavy boundary.

B3cs—18 to 22 inches, light olive-brown (2.5Y 5/3) clay loam, very dark grayish brown (2.5Y 3/2) crushing to dark grayish brown (10YR 4/2) moist; weak, coarse, prismatic structure; hard, firm, sticky and plastic; common fine nests of gypsum; strongly alkaline; abrupt, smooth boundary.

C1ca—22 to 32 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; few, fine, distinct relict mottles of reddish yellow (7.5YR 6/8) and gray (5Y 6/1); massive; hard, firm, sticky and plastic; few fine nests of gypsum; common, medium segregations of lime; strong effervescence; strongly alkaline; clear, smooth boundary.

C2—32 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; few, medium, distinct relict mottles of reddish yellow (7.5YR 6/8) and common, medium, distinct relict mottles of gray (5Y 6/1); massive; hard, firm, sticky and plastic; common medium segregations of lime; strong effervescence; strongly alkaline.

Depth to free carbonates ranges from 11 to 32 inches. The A1 horizon is dark grayish brown or grayish brown and is loam or silt loam. The A2 horizon is gray or light brownish gray and is loam or silt loam. Combined thickness of the A horizons is 5 to 10 inches. The B2t horizon is dark grayish brown or grayish brown in hue of 10YR or 2.5Y. In places the B21t has moderate structure. The B2t horizon is 6 to 12 inches thick. The B2 horizon is calcareous in some pedons.

Noonan soils are mapped with or are near Miranda and Niobell soils. They have a thicker A horizon than Miranda soils. Unlike Niobell soils, Noonan soils have a columnar B horizon.

Parnell Series

The Parnell series consists of deep, very poorly drained, level silty soils in closed depressions on uplands. These soils have a clayey subsoil. They formed in alluvium washed in from adjacent soils. The native vegetation is mainly tall grasses, reeds, and sedges.

In a representative profile about 3 inches of partly decayed organic material is on the surface. The surface layer of the mineral soil is dark-gray silty clay loam about 6 inches thick. The subsoil, about 42 inches thick, is dark-gray silty clay in the upper part and gray silty clay loam in the lower part. The underlying material is calcareous, gray silty clay loam.

Parnell soils have high content of organic matter and high fertility. Available water capacity is moderate or high, and permeability is slow. The water table is at or near the surface in the spring and usually is within a depth of 6 feet throughout the growing season.

Most areas are still in native vegetation and are used for grazing, hay, or wildlife habitat.

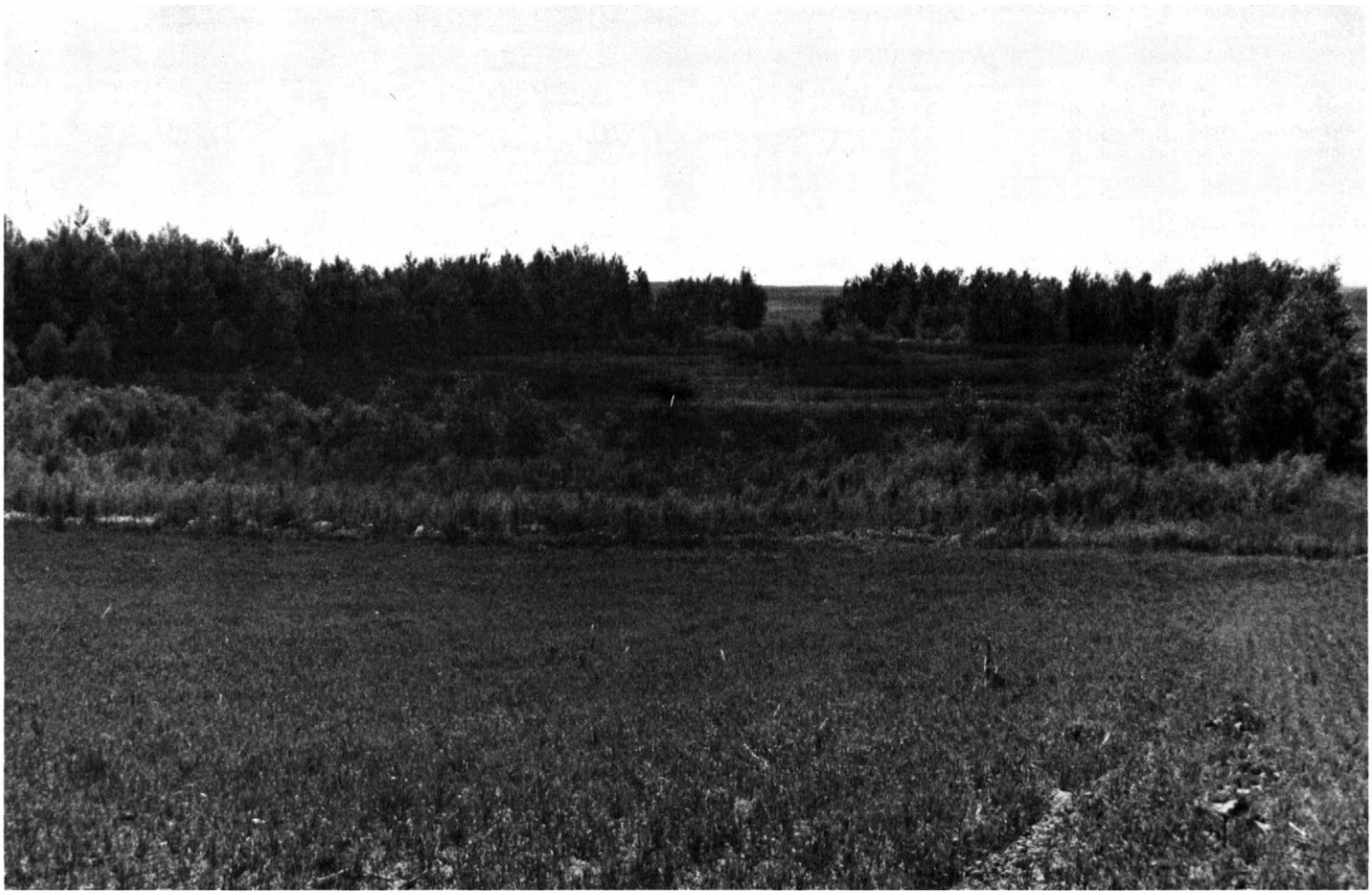


Figure 8.—**This area of Parnell silty clay loam is well suited for wildlife habitat.**

Representative profile of Parnell silty clay loam, 2,424 feet east and 66 feet south of the northwest corner of sec. 12, T. 123 N., R. 71 W.

O1—3 inches to 0, partially decayed organic material.
A1—0 to 6 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; moderate, fine and medium, granular structure; slightly hard, firm, sticky and plastic; slightly acid; clear, smooth boundary.
B21tg—6 to 9 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) moist; weak, medium, prismatic structure parting to strong, fine and medium, blocky; very hard, very firm, very sticky and very plastic; neutral; clear, smooth boundary.
B22tg—9 to 18 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) moist; moderate, medium, prismatic structure parting to moderate, medium, blocky; very hard, very firm, very sticky and very plastic; neutral; clear, smooth boundary.
B23tg—18 to 32 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) moist; weak, coarse, prismatic structure parting to moderate, medium, blocky; very hard, very firm, very sticky and very plastic; mildly alkaline; clear, smooth boundary.
B3g—32 to 48 inches, gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; common, fine, distinct mottles of dark olive (5Y 3/4) moist; weak, very coarse, prismatic structure; very hard, very firm, sticky, plastic; moderately alkaline; clear, smooth boundary.
Cgca—48 to 60 inches, gray (5Y 5/1) silty clay loam, very dark gray (5Y 3/1) moist; common, medium, distinct mottles of dark olive (5Y 3/4) moist; massive; hard, firm, sticky and plastic; common medium concretions of lime; strong effervescence; moderately alkaline.

Depth to free carbonates ranges from 35 to 60 inches. Some pedons lack an O1 horizon. The A1 horizon is slightly acid or neutral and is 6 to 12 inches thick. The B2tg horizon is dark-gray or gray silty clay or clay. The C horizon ranges from gray to light brownish gray in hue of 5Y or 2.5Y. Few or common, distinct or prominent mottles are in the B3 and C horizons.

Parnell soils are in closed depressions, as are Nishon and Tonka soils. They lack an A2 horizon and are more poorly drained than those soils.

Pa—Parnell silty clay loam. This level soil is in deeply entrenched depressions on uplands. Areas range from 3 to 160 acres in size. Slopes are 0 to 1 percent. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Heil, Nishon, and Tonka soils. These soils generally are at the edge of the areas forming a rim around the Parnell soil.

This Parnell soil is wet during most of the growing season. Runoff is ponded. Wetness is the chief concern of management.

If adequately drained, the soil is suited to most crops commonly grown in the county. In Edmunds County, however, drainage is not feasible on this soil in most areas. Most of the acreage is still native vegetation and is used for hay, grazing, or wildlife habitat (fig. 8). Capability unit Vw–4; Wetland range site; windbreak group 10.

Ranslo Series

The Ranslo series consists of deep, somewhat poorly drained, nearly level silty soils on bottom land. These soils have a claypan subsoil. They formed in alluvium. The native vegetation is mainly mid and tall grasses.

In a representative profile the surface layer is dark gray silt loam about 4 inches thick The subsurface layer is gray silt loam about 5 inches thick. The subsoil, about 26 inches thick, is very dark gray and gray silty clay loam in the upper part and calcareous, gray silty clay in the lower part. The upper part is very hard when dry and firm when moist. The underlying material is calcareous, light-gray and gray clay loam.

Ranslo soils have high content of organic matter and medium fertility. Available water capacity is moderate or high, and permeability is slow. Depth to a seasonal water table is less than 4 feet. Most areas are subject to occasional flooding.

Most areas are still in native grass and are used for hay or grazing.

Representative profile of Ranslo silt loam in an area of Ranslo-Harriet silt loams, 1,200 feet west and 135 feet south of the northeast corner of sec. 35, T. 122 N., R. 68 W.

A1—0 to 4 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist moderate, fine and medium, granular structure; soft, very friable, slightly plastic; neutral; clear, smooth boundary.

A2—4 to 9 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) crushing to very dark brown (10YR 2/2) moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; neutral; clear, smooth boundary.

B21t—9 to 14 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; weak, medium, prismatic structure parting to moderate, fine and medium, blocky; very hard, firm, sticky and plastic; neutral; abrupt, smooth boundary.

B22t—14 to 26 inches, gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; weak, coarse, prismatic structure parting to moderate, medium, blocky; very hard, firm, sticky and plastic; few fine segregations of lime and salt; strong effervescence; strongly alkaline; clear, smooth boundary.

B23t—26 to 35 inches, gray (10YR 6/1) silty clay, dark gray (10YR 4/1) moist; common, medium, prominent mottles of strong brown (7.5YR 5/6); weak, coarse, prismatic structure parting to moderate, fine, blocky; very hard, very firm, very sticky and very plastic; few fine segregations of lime and salt; strong effervescence; strongly alkaline; clear, wavy boundary.

Cca—35 to 60 inches, light-gray (2.5Y 7/1) and gray (2.5Y 6/1) clay loam, grayish brown (2.5Y 5/2) moist; massive; very hard, firm, sticky and plastic; many fine and medium segregations of lime and salt; violent effervescence; strongly alkaline.

The solum is 17 to 36 inches thick. Depth to free carbonates ranges from 10 to 25 inches. The A1 horizon is dark gray or gray and in places is silty clay loam. It is 3 to 6 inches thick. The A2 horizon ranges from gray to light brownish gray and is 2 to 6 inches thick. The B2t horizon ranges from very dark gray to light brownish gray in hue of 10YR or 2.5Y. The B2t horizon has prismatic structure that is weak or moderate and parts to moderate or strong blocky. It ranges from 12 to 24 inches in thickness. Some pedons have a B3ca horizon. The C horizon is clay loam, silty clay loam, silty clay, or clay. In places it is stratified with coarser textures below a depth of 40 inches.

Ranslo soils are mapped with Harriet soils and are similar to Noonan soils. They have a thicker A horizon and are better drained than Harriet soils. They have a more clayey B horizon and are more poorly drained than Noonan soils.

Rh—Ranslo-Harriet silt loams. This mapping unit is about 45 percent Ranslo soils, 40 percent Harriet soils, and 15 percent other soils. Areas are long and narrow in shape and range from 20 to 800 acres in size. They are on bottom land along drainageways. The soils are nearly level. The surface is uneven because of small mounds a few inches higher than the intervening low spots. Slopes are 0 to 2 percent. The Ranslo soil is on the mounds and the Harriet soil is in the low spots.

Included with these soils in mapping are small areas of Bearden, Divide, Grassna, and Spottswood soils. Bearden soils are near meandering channels. Divide and Spottswood soils are in places where sand and gravel are within a depth of 20 to 40 inches. Grassna soils are on slight rises. Also included in some areas in T. 123 N., R. 68 W. is a soil that is similar to Noonan soils, but is more poorly drained.

These soils are wet during much of the growing season because of a fluctuating water table. They also are subject to flooding after rapid snowmelt or heavy rains. Runoff is slow. Both soils have a claypan subsoil that limits growth of plant roots. Wetness and the salts in the Harriet soil are the main concerns in farming.

The Harriet soil is not suited to crops. In adequately drained areas the Ranslo soil is suited to cultivation, but in most areas the two soils are so intricately mixed that cultivation is not practical. Most areas are in native grass and are used for hay or grazing. Capability unit VIw–4; Ranslo soil in Subirrigated range site, windbreak group 2; Harriet soil in Saline Lowland range site, windbreak group 10.

Regan Series

The Regan series consists of deep, very poorly drained, level, calcareous silty soils on bottom land. These soils formed in alluvium. The native vegetation is mainly tall grasses, reeds, and sedges.

In a representative profile there is about one-half inch of partly decayed peaty material on the surface. The surface layer is gray silt loam about 5 inches thick. The underlying material to a depth of 44 inches is light-gray silt loam. The upper part has a very high content of lime. Below a depth of 44 inches is light olive-gray sand and gravel.

Regan soils have moderately low content of organic matter and low fertility. Available water capacity is moderate or high, and permeability is moderate. In most years, the water table is within a depth of 2 feet and is near the surface during part of the growing season.

Most of the areas are still in native vegetation and are used for hay, grazing, or wildlife habitat.

Representative profile of Regan silt loam, 240 feet west and 75 feet south of the northeast corner of sec. 6, T. 122 N., R. 73 W.

O1—½ inch to 0, grayish-brown (10YR 5/1) mainly fibric materials, very dark brown (10YR 2/2) moist.
A1—0 to 5 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak, medium, granular structure; soft, very friable; strong effervescence; mildly alkaline; clear, smooth boundary.
C1ca—5 to 12 inches, light-gray (2.5Y 7/1) silt loam, dark gray (2.5Y 4/1) moist; weak, fine, subangular blocky structure; soft, friable; violent effervescence; mildly alkaline; gradual, smooth boundary.
C2ca—12 to 24 inches, light-gray (2.5Y 7/1) silt loam, dark gray (2.5Y 4/1) moist; common, fine and medium, distinct mottles of strong brown (7.5YR 5/6) moist; weak, medium, subangular blocky structure; slightly hard, friable; violent effervescence; moderately alkaline; clear, smooth boundary.
C3g—24 to 44 inches, light-gray (5Y 7/2) silt loam, olive gray (5Y 5/2) moist; common, medium and coarse, distinct mottles of dark brown (7.5YR 3/2) moist and common, fine and medium, distinct mottles of yellowish brown (10YR 5/6) moist; massive; very hard, firm; slightly effervescence; mildly alkaline; abrupt, smooth boundary.
IIC4g—44 to 60 inches, light olive-gray (5Y 6/2) sand and gravel, olive gray (5Y 4/2) moist; single grained; loose; strong effervescence; mildly alkaline.

The O1 horizon is ½ to 1 inch thick. The A1 horizon is dark gray or gray and is 4 to 8 inches thick. The Cca horizon is light gray or gray and has calcium carbonate equivalent that ranges from 17 to 45 percent. The Cg horizon is light gray or gray and has a calcium carbonate equivalent that ranges from 17 to 45 percent. The Cg horizon has common or many, fine to coarse mottles. In places it is stratified with thin lenses of finer or coarser textured material.

Regan soils are more poorly drained than the nearby Bearden, Divide, Harriet, and Ranslo soils. They are more calcareous and contain less sodium and other salts than Harriet and Ranslo soils.

Rn—Regan silt loam. This nearly level soil is on bottom land along sluggish drainageways. Areas are long and narrow in shape and range from 20 to 200 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are small areas of Divide, Harriet, Parnell, Ranslo, Spottswood, and Tonka soils. Divide and Spottswood soils are on slight rises or on low terraces. Harriet and Ranslo soils are at the edge of some areas. Parnell and Tonka soils are in small depressions.

This Regan soil is not suited to cultivation because in most places it cannot be drained. Runoff is slow. Wetness from a high water table is the main concern of management.

All areas are still in native vegetation and are used for hay or grazing. Capability unit Vw–4; Wetland range site; windbreak group 10.

Spottswood Series

The Spottswood series consists of moderately well drained to somewhat poorly drained, nearly level loamy soils on uplands and terraces. These soils are moderately deep to sand and gravel. They formed in alluvium. The native vegetation was mainly mid and tall grasses.

In a representative profile the surface layer is dark-gray loam about 10 inches thick. The subsoil, about 14 inches thick, is dark-gray heavy loam in the upper part and light brownish-gray loam in the lower part. The underlying material to a depth of 30 inches is calcareous, light brownish-gray loam. Calcareous, grayish-brown sand and gravel are at a depth of 30 inches.

Spottswood soils have high content of organic matter and medium fertility. Available water capacity is moderate, and permeability is moderate in the subsoil and rapid in the underlying sand and gravel. In most years, depth to a seasonal water table ranges from 3 to 6 feet.

Most of the acreage is cultivated. A few small areas are still in native grass and are used for hay or grazing.

Representative profile of Spottswood loam, 1,584 feet south and 102 feet east of the northwest corner of sec. 32, T. 123 N., R. 73 W.

Ap—0 to 7 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, fine, granular structure; soft, very friable; neutral; abrupt, smooth boundary.
A12—7 to 10 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, medium, prismatic structure parting to weak, fine and medium, prismatic structure parting to weak, fine and medium, subangular blocky; soft, friable; neutral; clear, smooth boundary.
B2—10 to 20 inches, dark-gray (10YR 4/1) heavy loam, black (10YR 2/1) crushing to very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure parting to moderate, medium, subangular blocky; slightly hard, friable; neutral; abrupt, smooth boundary.
B3ca—20 to 24 inches, light brownish-gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure; hard, friable; few streaks of very dark grayish brown (10YR 3/2) moist on some vertical faces of peds; few fine and medium segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.
C1ca—24 to 30 inches, light brownish-gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, friable; common medium segregations of lime; strong effervescence; moderately alkaline; abrupt, wavy boundary.
IIC2—30 to 60 inches, dominantly grayish-brown (2.5Y 5/2) stratified sand and gravel, dark grayish brown (2.5Y 4/2) moist; single grained; loose; strong effervescence; moderately alkaline.

Depth to sand and gravel ranges from 20 to 40 inches. Depth to free carbonates ranges from 16 to 34 inches. The A horizon commonly is loam, but in places it is silt loam. It is neutral or slightly acid and is 6 to 14 inches thick. The B2 horizon is dark-gray or dark grayish-brown loam or light clay loam. It has weak or moderate, medium or coarse, prismatic structure that parts to weak or moderate, medium or coarse, subangular blocky. It is 10 to 20 inches thick. Few to many segregations of lime are in the B3ca and C1ca horizons. Some pedons have few or common, faint or distinct mottles in the B3 and C1 horizons. In places the IIC horizon contains few or common chips and fragments of soft shale.

Spottswood soils are near Bowdle and Divide soils. They are more poorly drained than Bowdle soils and are less calcareous than Divide soils.

Sp—Spottswood loam. This nearly level soil is along drainageways on uplands. Areas are irregular in shape and range from 15 to 80 acres in size. Slopes are 0 to 2 percent and generally are smooth.

Included with this soil in mapping are small areas of Bowdle, Divide, and Lehr soils. Bowdle and Lehr soils are on slight rises. Divide soils are in low spots.

This soil has a seasonal water table, and fieldwork may be delayed in wet years. The water table recedes

during the summer months, and the soil is somewhat droughty in most years because it is underlain by sand and gravel. Runoff is slow. Conserving moisture is the chief management need.

This soil is well suited to all crops commonly grown in the county, but in dry years it is best suited to early maturing crops. Most of the acreage is cultivated. Capability unit IIIs–2; Silty range site; windbreak group 3.

Tally Series

The Tally series consists of deep, well-drained, gently undulating loamy soils on uplands. These soils formed in glacial outwash that has been reworked and redeposited by wind. The native vegetation was mainly mid and tall grasses.

In a representative profile the surface layer is dark grayish-brown fine sandy loam about 8 inches thick. The subsoil, about 8 inches thick, is dark grayish-brown sandy loam. It is slightly hard when dry and very friable when moist. The underlying material to a depth of 29 inches is calcareous, grayish-brown sandy loam. Calcareous, light brownish-gray loamy fine sand is at a depth of 29 inches.

Tally soils have moderate content of organic matter and medium fertility. Available water capacity is low or moderate, and permeability is moderately rapid.

Most of the acreage is cultivated. A few small areas are still in native grass and are used for grazing.

Representative profile of Tally fine sandy loam, 2 to 6 percent slopes, 1,452 feet west and 123 feet north of fence from the southeast corner of sec. 32, T. 124 N., R. 66 W.

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) moist; weak and moderate, medium, granular structure; slightly hard, very friable; slightly acid; abrupt, smooth boundary.

B2—8 to 16 inches, dark grayish-brown (10YR 4/2) sandy loam, dark grayish brown (10YR 4/2) moist; weak, coarse, prismatic structure; few streaks of very dark brown (10YR 2/2) moist on vertical faces of peds; slightly hard, very friable; neutral; clear, wavy boundary.

C1ca—16 to 29 inches, grayish-brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) moist; weak, very coarse, prismatic structure; slightly hard, very friable; few very fine segregations of lime; strong effervescence; mildly alkaline; gradual, wavy boundary.

C2—29 to 60 inches, light brownish-gray (10YR 6/2) loamy fine sand, grayish brown (10YR 5/2) moist; massive; soft, very friable; few fine segregations of lime; strong effervescence; mildly alkaline.

The solum is 13 to 19 inches thick. The A horizon is dark grayish brown or dark gray. It commonly is fine sandy loam, but in places it is loam. It is 7 to 10 inches thick. The B2 horizon is dark grayish-brown to brown and sandy loam or fine sandy loam. It is 6 to 9 inches thick. The C horizon is loamy fine sand, sandy loam, or loamy sand. In places the C horizon is loam or clay loam glacial till below a depth of 40 inches. Segregations of lime in the C horizon are few or common and very fine to medium.

Tally soils are near Bryant, Letcher, and Williams soils. They contain more sand and less silt than Bryant soils. They are better drained and have a thinner A horizon than Letcher soils. They contain more sand and less clay than Williams soils.

TaB—Tally fine sandy loam, 2 to 6 percent slopes. This gently undulating soil is on uplands. Areas are irregular in shape and range from 10 to 160 acres in size. Slopes commonly are short and convex. In section 20, T. 122 N., R. 67 W., this soil is underlain by loam or clay loam at a depth of about 3 feet, but in all other areas this soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Bryant, Letcher, Niobell, Noonan, and Williams soils. Letcher, Niobell, and Noonan soils are in the lower parts of the landscape. Bryant and Williams soils are in the higher parts in some areas.

This Tally soil takes in water readily and runoff is slow. Soil blowing is a severe hazard. In dry years this soil is somewhat droughty. Controlling soil blowing and conserving moisture are the chief management needs.

This soil is suited to all crops commonly grown in the county, but in dry years it is better suited to small grain than to corn. Most of the acreage is cultivated. A few areas are still in native grass and are used for grazing or hay. Capability unit IIIe–8; Sandy range site; windbreak group 5.

Temvik Series

The Temvik series consists of deep, well-drained, gently sloping to sloping loamy soils on uplands. These soils formed in a mantle of glacial drift over glacial till. The native vegetation was a mixture of tall, mid, and short grasses.

In a representative profile the surface layer is dark grayish-brown loam about 6 inches thick. The subsoil, about 18 inches thick, is loam that is dark grayish brown in the upper part and light olive brown in the lower part. The upper part is slightly hard when dry and friable when moist. The underlying material to a depth of 37 inches is calcareous, light olive-brown loam. Below this it is calcareous, light brownish-gray clay loam.

Temvik soils have moderate content of organic matter and medium fertility. Available water capacity is high, and permeability is moderate in the subsoil and moderately slow in the underlying material.

Most of the acreage is cultivated. A few small areas are still in native grass and are used for grazing.

Representative profile of Temvik loam in an area of Temvik-Bryant loams, 2 to 6 percent slopes, 1,584 feet east and 102 feet north of the southwest corner of sec. 28, T. 123 N., R. 73 W.

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate, very fine, granular structure; slightly hard, very friable, slightly acid; abrupt, smooth boundary.

B21—6 to 14 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; neutral; clear, smooth boundary.

B22—14 to 24 inches, light olive-brown (2.5Y 5/4) loam, olive brown (2.5Y 4/4) moist; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; hard, very friable, slightly sticky and slightly plastic; neutral; abrupt, smooth boundary.

C1ca—24 to 37 inches, light olive-brown (2.5Y 5/4) loam, olive brown (2.5Y 4/4) moist; weak, medium, prismatic structure; hard, friable, slightly sticky and slightly plastic; thin lenses of sandy loam in

lower 3 inches; common fine segregations of lime; strong effervescence; moderately alkaline; abrupt smooth boundary.

IIC2—37 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm, slightly sticky and slightly plastic; common medium segregations of lime; strong effervescence; moderately alkaline.

Depth to loam or clay loam glacial till ranges from 20 to 40 inches. In places the lower part of the solum formed in glacial till. Depth to free carbonates ranges from 18 to 30 inches. The A horizon ranges from dark gray to grayish brown and in places is silt loam. It is 4 to 6 inches thick. The B2 horizon is loam or light clay loam that contains less than 15 percent fine or coarser sand. Some pedons have a B3 or B3ca horizon. The IIC horizon ranges from grayish-brown to light yellowish-brown clay loam or loam. In places the IIC horizon has few to many relict mottles.

Temvik soils are near Bryant and Grassna soils. They are shallower to firm glacial till and have a C horizon that contains less silt and very fine sand than Bryant soils. They are better drained and have a thinner A horizon than Grassna soils.

TbB—Temvik-Bryant loams, 2 to 6 percent slopes. This mapping unit is about 50 percent Temvik soils, 35 percent Bryant soils, and 15 percent other soils. Areas are irregular in shape and range from 40 to 200 acres in size. The smooth slopes commonly are more than 500 feet long. The Temvik soil commonly is in the mid and higher parts of the landscape. It has the profile described as representative of the series. The Bryant soil is in the lower part of the landscape.

Included with these soils in mapping are small areas of Bearden, Grassna, and Tally soils. Bearden and Grassna soils are in swales. Tally soils are on rises.

Runoff is medium. There is a moderate hazard of erosion and a slight risk of soil blowing. Controlling erosion is the chief management need.

These soils are well suited to all crops commonly grown in the county. Most of the acreage is cultivated. Capability unit IIe–1; Silty range site; windbreak group 3.

TgB—Temvik-Grassna loams, 3 to 6 percent slopes. This mapping unit is about 50 percent Temvik soils, 30 percent Grassna soils, and 20 percent other soils. Areas are irregular in shape and range from 40 to 120 acres in size. The soils are gently undulating because there are many narrow swales between rises. The Temvik soil is on the rises and the Grassna soil is in the swales.

Included with these soils in mapping are small areas of Bowbells, Bryant, and Williams soils. Bowbells soils are in swales. Bowdle soils are in places where sand and gravel are within a depth of 40 inches. Bryant soils are in the lower part of the landscape between Grassna and Temvik soils. Williams soils are on rises.

Runoff is medium and collects on the Grassna soil. Spring planting and tillage are delayed in some years by temporary wetness of the Grassna soil, but in most years the additional moisture is beneficial. Controlling erosion is the chief management need.

These soils are well suited to all crops commonly grown in the county. Most of the acreage is cultivated. Capability unit IIe–1; Silty range site; Temvik soil in windbreak group 3, Grassna soil in windbreak group 1.

TgC—Temvik-Grassna loams, 6 to 9 percent slopes. This mapping unit is about 50 percent Temvik soils, 25 percent Grassna soils, and 25 percent other soils. Areas are irregular in shape and range from 40 to 120 acres in size. These soils are undulating because there are many narrow swales between rises. The Temvik soil is on the rises. It has a thinner surface layer than in the profile described as representative of the series. Eroded spots commonly are in cultivated fields, and in these places the surface layer and the subsoil of the Temvik soil have been mixed by plowing. The Grassna soil is in the swales.

Included with these soils in mapping are small areas of Bowbells, Bryant, Lehr, Vida, and Zahill soils. Bowbells soils are in swales. Bryant soils are in the lower part of the landscape between Grassna and Temvik soils. Lehr soils are in places underlain by sand and gravel. Vida and Zahill soils are on the tops and upper sides of knolls and ridges.

Runoff is medium on the Temvik soil, and the hazard of erosion is severe. Spring planting and tillage are delayed in some years because runoff collects on the Grassna soil, but in most years the additional moisture is beneficial. Controlling erosion is the chief management need.

These soils are well suited to all crops commonly grown in the county. Most of the acreage is cultivated. Capability unit IIIe–1; Silty range site; Temvik soil in windbreak group 3, Grassna soil in windbreak group 1.

Tonka Series

The Tonka series consists of deep, poorly drained, level silty soils in closed depressions on uplands. These soils have a clayey subsoil. They formed in alluvium washed in from adjacent soils. The native vegetation is mainly mid grasses and sedges.

In a representative profile the surface layer is dark-gray silt loam about 6 inches thick. The subsurface layer is gray silt loam and silty clay loam about 7 inches thick. The subsoil, about 19 inches thick, is gray and dark-gray silty clay in the upper part and light brownish-gray silty clay loam in the lower part. The upper part is very hard when dry and very firm when moist. The underlying material is calcareous, light brownish-gray clay loam.

Tonka soils have moderate content of organic matter and medium fertility. Available water capacity is high, and permeability is slow.

Most of the acreage is still in native vegetation and is used for hay and grazing.

Representative profile of Tonka silt loam in an area of Tonka-Nishon silt loams, 90 feet east and 72 feet south of the northwest corner of sec. 34, T. 122 N., R. 66 W.

A1—0 to 6 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; moderate, fine and very fine, granular structure; soft, friable, slightly sticky and slightly plastic; neutral; clear, smooth boundary.

A21—6 to 9 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; common, fine, distinct mottles of yellowish brown (10YR 5/6) moist; moderate, very thin, platy structure; soft, friable, slightly sticky and slightly plastic; neutral; clear, smooth boundary.

A22—9 to 13 inches, gray (10YR 6/1) silty clay loam, dark gray (10YR 4/1) moist; common, medium, distinct mottles of yellowish brown (10YR 5/6) moist; moderate, thin and medium, platy structure; hard, firm, sticky and plastic; neutral; abrupt, smooth boundary.

B21t—13 to 17 inches, gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; weak, medium, prismatic structure parting to strong, fine, blocky; very hard, very firm, sticky and plastic; bleached sand grains on tops of prisms and along vertical faces of peds; neutral; gradual, smooth boundary.

B22t—17 to 24 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) moist; weak, medium, prismatic structure parting to strong, medium, blocky; very hard, very firm, sticky and plastic; mildly alkaline; clear, smooth boundary.

B3—24 to 32 inches, light brownish-gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; few, fine, faint mottles of olive yellow (2.5Y 6/6) moist; weak, coarse, prismatic structure; hard, firm, sticky and plastic; mildly alkaline; clear, smooth boundary.

C1ca—32 to 40 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; common, medium, distinct mottles of olive yellow (2.5Y 6/6) moist; massive; slightly hard, friable, sticky and plastic; common fine segregations of lime; strong effervescence; moderately alkaline; clear, smooth boundary.

C2ca—40 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; common, medium, distinct mottles of olive yellow (2.5Y 6/6) and gray (5Y 6/1) moist; massive; slightly hard, friable, sticky and plastic; many fine segregations of lime; violent effervescence; moderately alkaline.

Depth to free carbonates ranges from 28 to 48 inches. The A1 horizon is dark-gray or gray silt loam or silty clay loam. It is neutral or slightly acid and 6 to 10 inches thick. The A2 horizon is gray or light gray and has common or many mottles. It is neutral to medium acid and 4 to 10 inches thick. The B2t horizon has colors in hue of 10YR or 2.5Y and is silty clay or heavy silty clay loam. It has weak or moderate prismatic structure that parts to moderate or strong blocky. It is 8 to 27 inches thick. In places the C horizon is loam. Mottles in the lower part of the B horizon and in the C horizon range from few to many.

Tonka soils are in closed depressions, as are Nishon and Parnell soils. They have a thicker A1 horizon than Nishon soils. Unlike Parnell soils, they have an A2 horizon and are better drained than Parnell soils.

Tn—Tonka-Nishon silt loams. This mapping unit is about 50 percent Tonka soils, 40 percent Nishon soils, and 10 percent other soils. These soils are in depressions. Areas are circular to oval in shape and range from 3 to 30 acres in size. Slopes are 0 to 1 percent. The Nishon soil in some areas in T. 122 N., R. 67 W. has a sandy loam surface layer, but in all other areas both soils have the profiles described as representative of their series.

Included with these soils in mapping are small areas of Heil and Parnell soils. Heil soils are at the edge of some areas. Parnell soils are in the center or lowest part of depressions.

These soils are wet until late spring or early summer. Runoff is ponded. In undrained areas, planted crops commonly are drowned. Wetness is the main concern of management.

Undrained areas are better suited to late planted crops than to other crops. If adequately drained, these soils are suited to all crops commonly grown in the county. Many areas are still in native grass and are used for hay or grazing. A few areas are cultivated. Capability unit IIw–1 drained, IVw–1 undrained; Closed Depression range site; windbreak group 10.

Vida Series

The Vida series consists of deep, well-drained, gently undulating to hilly loamy soils on uplands. These soils formed in glacial till. The native vegetation is mainly mid and short grasses.

In a representative profile the surface layer is dark grayish-brown loam about 5 inches thick. The subsoil, about 8 inches thick, is clay loam that is dark grayish brown in the upper part and light brownish gray in the lower. It is slightly hard when dry and friable when moist. The lower part of the subsoil is calcareous. The underlying material is calcareous, light brownish-gray and pale-yellow clay loam.

Vida soils have moderate content of organic matter and medium fertility. Available water capacity is high, and permeability is moderate in the subsoil and moderately slow in the underlying material.

Many areas are cultivated. Some areas are still in native grass and are used for grazing or hay.

Representative profile of Vida loam in an area of Vida-Williams loams, 6 to 15 percent slopes, 2,575 feet north and 390 feet east of the southwest corner of sec. 15, T. 124 N., R. 73 W.

A1—0 to 5 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak and moderate, fine and medium, granular structure; soft, friable, slightly sticky and slightly plastic; neutral; clear, smooth boundary.

B2t—5 to 9 inches, dark grayish-brown (10YR 4/2) light clay loam, very dark brown (10YR 2/2) crushing to very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; mildly alkaline; abrupt, smooth boundary.

B3ca—9 to 13 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; few, fine, distinct relict mottles of brown (7.5YR 5/8); weak, coarse, prismatic structure; slightly hard, friable, sticky and plastic; common fine segregations of lime; strong effervescence; moderately alkaline; clear, smooth boundary.

C1ca—13 to 26 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm, sticky and plastic; common medium segregations of lime; strong effervescence; moderately alkaline; clear, smooth boundary.

C2—26 to 60 inches, pale-yellow (2.5Y 7/4) clay loam, light olive brown (2.5Y 5/4) moist; common, medium, distinct relict mottles of gray (5Y 6/1) and yellowish red (5YR 5/8); massive; hard, firm, sticky and plastic; common fine segregations of lime; strong effervescence; moderately alkaline.

Depth to free carbonates ranges from 6 to 10 inches under natural conditions, but in cultivated areas the Ap horizon commonly is calcareous. The A1 horizon is dark grayish brown or dark gray and is 3 to 7 inches thick. The B2 horizon is dark grayish brown or grayish brown in hue of 10YR or 2.5Y. In places the C horizon is loam. In some pedons, the B3 and C horizons lack mottles.

Vida soils are mapped with Williams and Zahill soils. They have a thinner B2t horizon and are shallower to lime than Williams soils. They have moist colors of very dark grayish brown or darker to greater depths than Zahill soils. Unlike Zahill soils, they have a B2t horizon.

VdC—Vida stony loam, 3 to 15 percent slopes. This gently undulating to rolling soil is on uplands. Areas are long and narrow in shape and range from 10 to 100 acres in size. Slopes commonly are short and convex. Stones are scattered on the surface, especially on the tops and upper sides of ridges and knolls.

Included with this soil in mapping are small areas of Wabek and Williams soils. Wabek soils are on the tops

of ridges. William soils are in the lower parts of the landscape.

This Vida soil is too stony for use of farming or haying equipment. Runoff is medium.

All of the acreage is still in native grass and is used for grazing. Capability unit VIIs–6; Silty range site; windbreak group 10.

VwC—Vida-Williams loams, 6 to 15 percent slopes. This mapping unit is about 45 percent Vida soils, 35 percent Williams soils, and 20 percent other soils. Areas are irregular in shape and range from 40 to 320 acres in size. The soils are undulating to rolling. Slopes are mostly short and convex. Stones are scattered on the surface on some of the ridges. Eroded spots are present in some of the cultivated areas, and in these areas the surface layer and subsoil have been mixed by plowing. The Vida soil is in the mid and higher parts of the landscape. It has the profile described as representative of the series. The Williams soil is in the lower part of the landscape.

Included with these soils in mapping are small areas of Bowbells, Tonka, and Zahill soils. Bowbells soils are in swales. Tonka soils are in small depressions, which are identified on the soil map by a wet spot symbol. Zahill soils are on the tops of the ridges and knolls.

Runoff is medium, and these soils have a severe hazard of erosion. Content of organic matter is low in the eroded spots. Controlling erosion is the chief management need.

This Vida soil is too erodible for cultivation, but the Williams soil is suited to small grain and alfalfa. Many areas are cultivated. Some are still in native grass and are used for grazing or hay. Silty range site; Vida soil in capability unit VIe–3, windbreak group 10; Williams soil in capability unit IVe–1, windbreak group 3.

VzE—Vida-Zahill loams, 15 to 25 percent slopes. This mapping unit is about 45 percent Vida soils, 30 percent Zahill soils, and 25 percent other soils. These hilly soils are on uplands. Areas are irregular in shape and range from 20 to 160 acres in size. Slopes are short and convex. Stones are scattered on the surface in the higher parts of the landscape in some areas. Vida soils are in the middle parts of the landscape, and Zahill soils are in the higher parts. The Zahill soil has the profile described as representative of the series.

Included with these soils in mapping are small areas of Bowbells, Parnell, and Williams soils. Of these, Williams soils are the most extensive and are as much as 20 percent of some areas. They are in the lower parts of the landscape. Bowbells soils are in swales. Parnell soils are in small depressions, most of which are less than 2 acres in size. They are identified on the maps by a wet spot symbol.

Runoff is medium to rapid, and the hazard of erosion is very severe. These soils are too steep and erodible for cultivation.

Most of the acreage is still in native grass and used for grazing. A few areas are cultivated. Capability unit VIe–3; windbreak group 10; Vida soil in Silty range site, Zahill soil in Thin Upland range site.

Wabek Series

The Wabek series consists of excessively drained, undulating to hilly soils on uplands. These soils are very shallow to sand and gravel. They formed in glacial outwash. The native vegetation is mainly short grasses.

Figure 9.—**Sand and gravel in Wabek loam.**

In a representative profile the surface layer is dark grayish-brown loam about 4 inches thick. The underlying material, to a depth of 7 inches, is calcareous, dark grayish-brown gravelly sandy loam. It is slightly hard when dry and very friable when moist. Below a depth of 7 inches it is calcareous, light-gray and light brownish-gray sand and gravel (fig. 9).

Wabek soils have moderately low content of organic matter and low fertility. Available water capacity is very low or low, and permeability is rapid.

Some of the acreage is cultivated. Other areas are still in native grass and are used for grazing.

Representative profile of Wabek loam, 6 to 20 percent slopes, 1,640 feet east and 18 feet north of fence from the southwest corner of sec. 27, T. 123 N., R. 73 W.

A1—0 to 4 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak, fine and medium, granular structure; slightly hard, very friable; neutral; clear, smooth boundary.

IIC1—4 to 7 inches, dark grayish-brown (10YR 4/2) gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, very friable; thin coatings of lime on pebbles; slight effervescence; mildly alkaline; clear, wavy boundary.

IIC2—7 to 60 inches, dominantly light-gray (2.5Y 7/2) and light brownish-gray (2.5Y 6/2) stratified sand and gravel, grayish brown (2.5Y 5/2) and dark grayish brown (2.5Y 4/2) moist; single grained; loose; strong effervescence; mildly alkaline.

Depth to stratified sand and gravel ranges from 7 to 14 inches. Depth to free carbonates ranges from 4 to 9 inches. The A1 horizon is dark grayish brown or grayish brown. It commonly is loam but in places is gravelly loam, gravelly sandy loam, or sandy loam. It is 4 to 7 inches thick. The IIC horizon ranges from dark grayish brown to pale yellow.

Wabek soils are shallower to sand and gravel than the nearby Bowdle and Lehr soils. Unlike those soils, Wabek soils lack a B horizon.

WaD—Wabek loam, 6 to 20 percent slopes. This undulating to hilly soil is on uplands. Areas are long and narrow in shape and range from 10 to 60 acres in size. Slopes are short and convex. Small stony spots are on the crests of ridges in some areas. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Bowdle and Lehr soils in the lower part of the landscape.

Runoff is slow. This soil is droughty because it is underlain by sand and gravel. It is not suited to cultivation. Conserving moisture is the chief management need.

Most of the acreage is still in native grass and is used for grazing. Only a few areas are cultivated. Capability unit VIIs–4; Very Shallow range site; windbreak group 10.

WbC—Wabek-Bowdle loams, 6 to 15 percent slopes. This mapping unit is about 35 percent Wabek soils, 35 percent Bowdle soils, and 30 percent other soils. These undulating to rolling soils are on uplands. Areas are irregular in shape and range from 10 to 120 acres in size. Slopes are short and convex. Stones are scattered on the surface in some areas on the tops of ridges and knolls. The Wabek soil is in the higher part of the landscape. In cultivated areas, the surface layer is gravelly and light colored because it has been mixed with the underlying material by plowing. The Bowdle soil is in the lower part of the landscape.

Included with these soils in mapping are small areas of Bowbells, Lehr, and Tally soils. Of these, Lehr soils are the most extensive and make up as much as 25 percent of some areas. They are in the higher part of the landscape with Wabek soils. Bowbells and Tally soils are in swales.

Runoff is slow to medium. Cultivated areas are subject to erosion and soil blowing. The Wabek soil is too droughty for crops because it is underlain by sand and gravel at very shallow depths. Conserving moisture and controlling erosion and soil blowing are the chief management needs.

Farming is not practical in many areas because of the intricate pattern of these soils. Some areas are still in native grass and are used for grazing, but many areas are cultivated. Wabek soil in capability unit VIIs–4, Very Shallow range site, windbreak group 10; Bowdle soil in capability unit IVe–5, Silty range site, windbreak group 6.

Williams Series

The Williams series consists of deep, well-drained, nearly level to rolling loamy soils on uplands. These soils formed in glacial till. The native vegetation was a mixture of tall, mid, and short grasses.

Figure 10.—**Lime is at a depth of about 16 inches in Williams loam in an area of Williams-Bowbells loams, 3 to 6 percent slopes.**

In a representative profile (fig. 10) the surface layer is dark grayish-brown loam about 4 inches thick. The subsoil, about 20 inches thick, is clay loam that is grayish brown in the upper part and light brownish gray in the lower part. The upper part is hard when dry and friable when moist. The lower part is calcareous and has spots and streaks of lime that extend

into the underlying material. The underlying material is calcareous, light-gray and light yellowish-brown clay loam.

Williams soils have moderate content of organic matter and medium fertility. Available water capacity is high, and permeability is moderate in the subsoil and moderately slow in the underlying material.

Many areas are cultivated, but extensive areas are still in native grass and are used for grazing or hay.

Representative profile of Williams loam in an area of Williams-Bowbells loams, 3 to 6 percent slopes, 2,030 feet west and 75 feet north of the southeast corner of sec. 29, T. 123 N., R. 69 W.

A1—0 to 4 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate, fine and medium, granular structure; slightly hard, very friable; neutral; clear, smooth boundary.

B21t—4 to 10 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to moderate, fine and medium, subangular blocky; hard, friable; shiny coats on faces of blocks; neutral; clear, smooth boundary.

B22t—10 to 16 inches, grayish-brown (2.5Y 5/2) clay loam, dark brown (10YR 4/3) moist; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; hard, friable; shiny coats on faces of blocks; neutral; abrupt, wavy boundary.

B3ca—16 to 24 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; few, fine, faint relict mottles of light gray (10YR 7/1) and yellowish brown (10YR 5/6) moist; weak, coarse, prismatic structure; slightly hard, friable; common medium segregations of lime; strong effervescence; mildly alkaline; gradual, smooth boundary.

C1—24 to 35 inches, light-gray (2.5Y 7/2) clay loam, light olive brown (2.5Y 5/4) moist; common, medium, distinct relict mottles of light gray (10YR 7/1) and yellowish brown (10YR 5/6) moist; massive; slightly hard, friable; common fine segregations of lime; strong effervescence; moderately alkaline; gradual, smooth boundary.

C2—35 to 60 inches, light yellowish-brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) moist; common, medium, distinct relict mottles of light gray (10YR 7/1) and few, fine, prominent mottles of strong brown (7.5Y 5/8) moist; massive; hard, friable; slight effervescence; mildly alkaline.

The solum ranges from 16 to 36 inches in thickness. Depth to free carbonates ranges from 10 to 24 inches. The A horizon commonly is dark grayish brown or grayish brown but in places the upper part is dark gray. It commonly is loam, but in places it is light clay loam or silt loam. It is 4 to 8 inches thick. The B2t horizon ranges from dark grayish brown to light brownish gray. It commonly is clay loam, but in places is heavy loam, and it has weak or moderate and medium or coarse prismatic structure. It is 6 to 16 inches thick. Segregations of lime in the B3ca and C1ca horizons are few to many. The B3 horizon is 6 to 12 inches thick.

Williams soils are mapped with or are near Bowbells, Bryant, and Vida soils. They have a thinner A horizon and are better drained than Bowbells soils. They contain less silt and very fine sand in the B horizon than Bryant soils. They are deeper to free carbonates than Vida soils.

WnB—Williams-Bowbells loams, 3 to 6 percent slopes. This mapping unit is about 65 percent Williams soils, 20 percent Bowbells soils, and 15 percent other soils. Areas are irregular in shape and range from 15 to 750 acres in size. The soils are gently undulating and slopes are generally short. The Williams soil is on convex rises and the Bowbells soil is in swales between the rises. Both soils have the profiles described as representative of their series.

Included with these soils in mapping are small areas of Bryant, Cresbard, Niobell, Nishon, Tonka, and Vida soils. Bryant soils are on rises. Cresbard soils are in swales with Bowbells soils. Nishon and Tonka soils are in small depressions, and most of these areas are identified on the soil map by a wet spot symbol. Vida soils are in the higher part of the landscape.

Runoff is medium and collects on the Bowbells soil. Spring planting and tillage are delayed in some years, but in most years the additional moisture is beneficial. Controlling erosion is the chief management need.

These soils are well suited to all crops commonly grown in the county. Much of the acreage is cultivated. A few areas are still in native grass and are used for grazing or hay. Capability unit IIe–2; Silty range site; Williams soil in windbreak group 3, Bowbells soil in windbreak group 1.

WnC—Williams-Bowbells loams, 6 to 9 percent slopes. This mapping unit is about 60 percent Williams soils, 20 percent Bowbells soils, and 20 percent other soils. These undulating soils are on uplands. Areas are irregular in shape and range from 40 to 160 acres in size. Slopes are moderately long in some places and short and irregular in others. The Williams soil is on convex rises. It has a thinner surface layer than in the profile described as representative of the series, and in eroded spots the surface layer has been mixed with the subsoil by plowing. The Bowbells soil is in swales between the rises.

Included with these soils in mapping are small areas of Bryant, Cresbard, Parnell, Temvik, Tonka, Vida, and Zahill soils. Bryant soils and Temvik soils are on smooth ridges that are mantled by silty glacial drift. Cresbard soils are in swales. Parnell and Tonka soils are in small depressions. Most of these areas are identified on the soil map by a wet spot symbol. Vida and Zahill soils are on the tops and upper sides of ridges and knolls.

Runoff is medium and erosion is a severe hazard on the Williams soils. Spring planting and tillage are delayed in some years by runoff collecting on the Bowbells soil, but in most years the additional moisture is beneficial. Controlling erosion is the chief management need.

These soils are suited to all crops commonly grown in the county. Much of the acreage is cultivated, but some areas are still in native grass and are used for grazing or hay. Capability unit IIIe–2; Silty range site; Williams soil in windbreak group 3, Bowbells soil in windbreak group 1.

WtA—Williams-Bowbells-Nishon complex, 0 to 2 percent slopes. This mapping unit is about 50 percent Williams soils, 25 percent Bowbells soils, 15 percent Nishon soils, and 10 percent other soils. Areas are irregular in shape and range from 80 to 1,500 acres in size. The soils are level to nearly level; differences in relief are less than 5 feet. The very slight rises are broken by numerous narrow swales and many small depressions. There are 70 to 100 of these depressions per section. The Williams soil is on very slight rises, the Bowbells soil is in swales, and the Nishon soil is in depressions. These soils have a surface layer of loam and silt loam.

Included with these soils in mapping are small areas

of Cresbard, Niobell, Noonan, and Tonka soils. Cresbard soils are in swales with Bowbells soils. Niobell soils are intermingled with Williams soils in places. Tonka soils are in depressions.

Runoff is slow on the Williams and Bowbells soils and ponds on the Nishon soil. The Williams and Bowbells soils have only slight limitations to use for crops other than moisture deficiencies caused by dry periods. Fieldwork is commonly delayed by wetness of the Nishon soil. Conserving moisture on the Williams and Bowbells soils and wetness on the Nishon soil are the main concerns of management.

The Williams and Bowbells soils are well suited to all crops commonly grown in the county, but the Nishon soil is better suited to late planted crops or to hay and pasture unless it is drained. Much of the acreage is cultivated. A few areas are still in native grass and are used for hay or grazing. Williams soil in capability unit IIc–2, Silty range site, windbreak group 3; Bowbells soil in capability unit IIc–3, Overflow range site, windbreak group 1; Nishon soil in capability unit IIw–1 drained, IVw–1 undrained, Closed Depression range site, windbreak group 10.

WtB—Williams-Bowbells-Nishon complex, 2 to 6 percent slopes. This mapping unit is about 50 percent Williams soils, 20 percent Bowbells soils, 10 percent Nishon soils, and 20 percent other soils. These gently undulating soils are on uplands. Areas are irregular in shape and range from 80 to 1,500 acres in size. They contain many narrow swales and closed depressions. There are 60 to 90 closed depressions per section. Slopes are short; differences in elevation are about 10 feet. The Williams soil is on convex rises, the Bowbells soil is in swales, and the Nishon soil is in depressions. These soils have a surface layer of loam and silt loam.

Included with these soils in mapping are small areas of Bryant, Cresbard, Lehr, Niobell, Noonan, Parnell, Tonka, and Vida soils. Bryant, Niobell, and Noonan soils are on rises intermingled with Williams soils. Cresbard soils are in swales with Bowbells soils. Lehr soils are in places underlain by sand and gravel. Parnell and Tonka soils are in depressions. Vida soils are on the tops of ridges and knolls.

Runoff is medium on the Williams and Bowbells soils and ponds on the Nishon soil. Wetness of the Nishon soil delays fieldwork in some years. Controlling erosion on the Williams and Bowbells soils and wetness on the Nishon soil are the main concerns of management.

The Williams and Bowbells soils are well suited to all crops commonly grown in the county, but the Nishon soil is better suited to late planted crops or to hay and pasture unless it is drained. Much of the acreage is cultivated, but some areas are still in native grass and are used for grazing and hay. Williams soil in capability unit IIe–2, Silty range site, windbreak group 3; Bowbells soil in capability unit IIe–2, Silty range site, windbreak group 1; Nishon soil in capability unit IIw–1 drained, IVw–1 undrained, Closed Depression range site, windbreak group 10.

WvC—Williams-Bowbells-Parnell complex, 6 to 9 percent slopes. This mapping unit is about 45 percent Williams soils, 20 percent Bowbells soils, 10 percent Parnell soils, and 25 percent other soils. These undulating soils are on uplands. Areas are irregular in shape and range from 80 to 400 acres in size. They contain many narrow swales and deeply entrenched depressions. Slopes are short. Elevation differences range to as much as 25 feet. The higher part of some landscapes has stones and boulders scattered on the surface. The Williams soil is on the sides of ridges and knolls. It has a thinner surface layer than that of the profile described as representative of the series. The Bowbells soil is in swales, and the Parnell soil is in depressions. There are 60 to 90 depressions per section. These soils have a surface layer of loam and silty clay loam.

Included with these soils in mapping are small areas of Bryant, Cresbard, Lehr, Nishon, Tonka, Vida, and Zahill soils. Bryant soils are on smooth ridges that are mantled by silty glacial drift. Cresbard soils are in swales. Lehr soils are in places underlain by sand and gravel. Nishon and Tonka soils are in depressions. Vida and Zahill soils are on the tops and upper sides of ridges and knolls.

Runoff is medium on the Williams and Bowbells soils and ponds on the Parnell soil. On Williams and Bowbells soils the hazard of erosion is severe. The Parnell soil is wet during the growing season. Controlling erosion on the Williams and Bowbells soils and wetness on the Parnell soils are the main concerns of management.

The Williams and Bowbells soils are suited to all crops commonly grown in the county. If adequately drained, the Parnell soil also can be farmed. Drainage is not feasible in most areas, and this Parnell soil is better suited to grazing, hay, and wildlife habitat. Some of the acreage of this mapping unit is cultivated. Many areas are still in native grass and are used for grazing and hay. Williams soil in capability unit IIIe–2, Silty range site, windbreak group 3; Bowbells soil in capability unit IIIe–2, Silty range site, windbreak group 1; Parnell soil in capability unit Vw–4, Wetland range site, windbreak group 10.

Zahill Series

The Zahill series consists of deep, excessively drained, hilly loamy soils on uplands. These soils formed in glacial till. The native vegetation is mainly short grasses.

In a representative profile the surface layer is dark grayish-brown loam about 4 inches thick. The underlying material is calcareous, pale-brown and light brownish-gray clay loam.

Zahill soils have low content of organic matter and low fertility. Available water capacity is high, and permeability is moderate to a depth of 18 inches and moderately slow in the underlying glacial till.

Most of the acreage is still in native grass and is used for grazing. A few small areas are cultivated.

Zahill soils in Edmunds County are mapped only with Vida soils.

Representative profile of Zahill loam in an area of Vida-Zahill loams, 15 to 25 percent slopes, 510 feet south and 30 feet east of the northwest corner of sec. 33, T. 124 N., R. 73 W.

A1—0 to 4 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak and

moderate, fine and medium, granular structure; slightly hard, friable, slightly plastic; slight effervescence, mildly alkaline; clear, smooth boundary.

C1ca—4 to 18 inches, pale-brown (10YR 6/3) clay loam, olive brown (2.5Y 4/4) moist; common, medium, faint relict mottles of brownish yellow (10YR 6/8); weak, medium, prismatic structure parting to weak, medium, subangular blocky; hard, friable, sticky and plastic; common medium segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C2—18 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, light olive brown (2.5Y 5/4) moist; common, fine, distinct relict mottles of reddish yellow (7.5YR 6/8); massive; hard, friable, sticky and plastic; few medium segregations of lime; strong effervescence; moderately alkaline.

Free carbonates are at or near the surface. The A1 horizon under native grass is dark grayish-brown loam or clay loam and is 2 to 4 inches thick. In cultivated areas the Ap horizon has moist colors of dark grayish brown or grayish brown because it has been mixed with the C horizon by plowing. The C horizon is grayish-brown to light yellowish-brown clay loam or loam. Relict mottles are few or none in some pedons.

Zahill soils are mapped with Vida soils and are hilly like Wabek soils. They lack a B horizon and have moist colors of very dark grayish brown or darker to shallower depths than Vida soils. They have a C horizon of clay loam or loam, unlike Wabek soils, which have a C horizon of sand and gravel.

Use and Management of the Soils

This section describes the use and management of the soils for crops, tame pasture, range, windbreaks, wildlife, and engineering structures. Table 2 lists predicted average yields for the principal crops under two levels of management.

Crops[3]

About 70 percent of Edmunds County is cultivated. This is the dominant land use in all parts of the county but the Williams-Vida soil association. Wheat, oats, rye, corn, and alfalfa are the main crops. Barley and flax are also important.

Successful long-term cultivation of any soil depends on managing that soil according to its capabilities and limitations for crops. The main objectives in managing cultivated soils in the county are conserving moisture, controlling erosion and soil blowing, and maintaining fertility and tilth.

A sound conservation cropping system based on the properties of each soil or group of soils must be used. Some soils can be used for a single crop for many years without damage to the physical condition of the soil. Other soils deteriorate rapidly when used continuously for one crop, especially if that crop produces little residue. A cropping system based on the properties of a soil helps maintain tilth; reduces insect, disease, and weed infestations; and helps control erosion and soil blowing. In most areas such a cropping system conserves moisture and maintains fertility.

In Edmunds County conserving moisture generally means distributing snow evenly, reducing evaporation, limiting runoff, and controlling weeds. Minimum tillage, stubble mulching, crop residue use, wind stripcropping, field windbreaks or barriers, contour farming, terracing, and timely tillage are helpful measures. These practices also help control erosion and soil blowing. Where needed, grassed waterways, diversions, and emergency tillage also help control erosion and soil blowing. Usually a combination of practices is used.

Measures that help to maintain soil tilth and structure are stubble mulching, minimum tillage, crop residue use, green-manure crops, and use of grasses or legumes in the cropping system. These measures, along with applications of barnyard manure and chemical fertilizers, help maintain fertility. Controlling erosion and soil blowing also helps to maintain fertility.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The groups are made according to the limitations of the soils when used for field crops, the risk of damage when they are 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 rice, cranberries, horticultural crops, or other crops requiring 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 limitations of groups of soils for range, for forest trees, or for engineering.

In the capability system, all kinds of soil are grouped at three levels, the capability class, the subclass, and the unit. These levels are described in the following paragraphs.

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

Class I soils have few limitations that restrict their use. (None in Edmunds County.)

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

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 unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife.

Class VII soils have very severe limitations that

[3] By PAUL M. BODEN, conservation agronomist, Soil Conservation Service.

make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife.

Class VIII soils and landforms have limitations that preclude their use for commercial crops and restrict their use to recreation, wildlife, or 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, IIe. The letter *e* shows that the main limitation is the hazard of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is 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, although they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management (*5*). Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–4 or IIIe–6. 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.

Capability units

The capability units in Edmunds County are described on the following pages, and the use and management of the soils is suggested. The capability units within a capability subclass are not numbered consecutively, because not all of the units in the statewide system are used in this county. To find the capability classification of a given soil in this county, refer to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT IIe–1

This unit consists of deep, well drained and moderately well drained, gently sloping soils on uplands. These soils have a loam surface layer and a friable loam or clay loam subsoil. Slopes are mostly long and smooth.

These soils are moderate to high in content of organic matter, are medium to high in fertility, and have high available water capacity. Permeability is moderate in the subsoil and moderate or moderately slow in the underlying material. Runoff is medium, and the hazard of erosion is moderate. In some years, spring planting is delayed temporarily by wetness of the moderately well drained soil. Controlling erosion is the chief management need. Other management needs are controlling soil blowing, conserving moisture, and maintaining fertility.

These soils are well suited to all crops grown in the county. Wheat, oats, rye, corn, and alfalfa are the main crops. Barley and flax are also grown.

Stubble mulching, crop residue use, minimum tillage, contour farming, terraces, and grassed waterways help control erosion and soil blowing, conserve moisture, and maintain fertility. Wind stripcropping and field windbreaks (fig. 11) also are effective in controlling soil blowing and conserving moisture.

CAPABILITY UNIT IIe–2

This unit consists of deep, well drained and moderately well drained, gently undulating soils on uplands. These soils have a loam surface layer and a friable clay loam subsoil. Slopes are mostly short and irregular.

These soils are moderate to high in content of organic matter, medium to high in fertility, and have high available water capacity. Permeability is moderate in the subsoil and moderately slow in the underlying material. Runoff is medium, and the hazard of erosion is moderate. In some years, spring planting is delayed temporarily by wetness of the moderately well drained soil. Controlling erosion is the chief management need. Other management needs are controlling soil blowing, conserving moisture, and maintaining fertility.

These soils are well suited to all crops grown in the county. Wheat, oats, rye, corn, and alfalfa are the main crops. Barley and flax also are grown.

Stubble mulching, crop residue use, minimum tillage, wind stripcropping, and field windbreaks help control erosion and soil blowing, conserve moisture, and maintain fertility. Slopes are too irregular in most areas for contour farming and terraces.

CAPABILITY UNIT IIe–4

Bearden loam, the only soil in this unit, is a deep, somewhat poorly drained, nearly level, calcareous soil that has a loam surface layer and a silt loam subsoil.

This soil is moderate in content of organic matter, is medium in fertility, and has high available water capacity. Runoff is slow, and the water table is at a depth ranging from 3 to 5 feet during the early part of the growing season. In wet years, fieldwork is delayed in spring. This soil has a high content of lime and is moderately susceptible to soil blowing. Controlling soil blowing is the chief management need. Other management needs are conserving moisture and maintaining fertility.

This soil is well suited to all crops grown in the county. Wheat, oats, rye, corn, and alfalfa are the main crops. Barley and flax also are grown.

Stubble mulching, crop residue use, minimum tillage, wind stripcropping, and field windbreaks help control soil blowing, conserve moisture, and maintain fertility.

CAPABILITY UNIT IIw–1

This unit consists of deep, poorly-drained, level soils in closed depressions on uplands. These soils have a

Figure 11.—This 4-year-old, single-row field windbreak on Temvik-Bryant loams, 2 to 6 percent slopes, helps control soil blowing and traps snow.

silt loam surface layer and a clay or silty clay subsoil.

These soils are moderate to moderately low in content of organic matter, are medium in fertility, and have high available water capacity. Permeability is slow. Runoff is ponded, but drainage has been provided or is feasible. In wet years fieldwork is delayed. Wetness is the chief concern of management. Other management needs are improving water intake and maintaining tilth and fertility.

If adequately drained, these soils are suited to all crops grown in the county. In wet years, they are better suited to such late-planted crops as corn, sorghum, or millet than to small grain.

Stubble mulching, crop residue use, timely tillage, and grasses and legumes in the cropping system help improve water intake and maintain tilth and fertility. Maintaining drainage structures is essential to the continued use of these soils for annual crops. Controlling runoff from adjacent soils helps reduce wetness.

CAPABILITY UNIT IIs–1

This unit consists of deep, well drained to moderately well drained, nearly level soils that have a clayey subsoil. These soils are on uplands. They have a silty clay loam surface layer and a silty clay subsoil.

These soils are moderate or high in content of organic matter, are medium in fertility, and have high available water capacity. Permeability is moderately slow or slow. Runoff is slow. These soils dry slowly in spring, and in summer the clayey subsoil releases moisture slowly to plants. If the soils are cultivated, tilth deteriorates and there is a moderate risk of soil blowing. Improving water intake, maintaining tilth, and controlling soil blowing are the chief management needs. Other management needs are conserving moisture and maintaining fertility.

These soils are well suited to all crops grown in the county. Wheat, oats, rye, corn, and alfalfa are the main crops.

Stubble mulching, crop residue use, minimum tillage, timely tillage, chiseling or subsoiling, wind stripcropping, and field windbreaks improve water intake, conserve moisture, control soil blowing, and maintain tilth and fertility.

CAPABILITY UNIT IIc–2

This unit consists of deep, well drained, nearly level soils on uplands. These soils have a loam surface layer and a clay loam subsoil.

These soils are moderate in content of organic matter, are medium in fertility, and have high available water capacity. Permeability is moderate in the subsoil and moderate to moderately slow in the underlying

Figure 12.—Stubble mulching and a single-row field windbreak help trap snow for maximum moisture conservation in this area of Bryant loam, 0 to 2 percent slopes.

material. These soils have only slight limitations for crops. Shortage of moisture occurs in dry years, and there is a slight risk of soil blowing. Conserving moisture is the chief management need. Other important management needs are controlling soil blowing and maintaining fertility.

These soils are well suited to all crops grown in the county. Wheat, oats, rye, corn, and alfalfa are the main crops. Barley and flax also are grown.

Stubble mulching, crop residue use, minimum tillage, wind stripcropping, and field windbreaks (fig. 12) help conserve moisture, control soil blowing, and maintain fertility.

CAPABILITY UNIT IIc–3

This unit consists of deep, moderately well drained, nearly level soils in swales on uplands. These soils have a loam surface layer and a loam or clay loam subsoil.

Most of these soils are high in content of organic matter and have high fertility and high available water capacity. Permeability is moderate in the subsoil and moderate to moderately slow in the underlying material. In the subsoil of a soil in one complex in this unit, permeability is moderately slow to slow. Runoff is slow. Fieldwork is temporarily delayed in some years because runoff from adjacent soils collects in swales. These soils, however, have few or no limitations for crops other than moisture deficiencies in some years.

These soils are well suited to all crops grown in the county. Wheat, oats, rye, corn, and alfalfa are the main crops. Barley and flax also are grown.

Stubble mulching, crop residue use, and minimum tillage help conserve moisture.

CAPABILITY UNIT IIIe–1

This unit consists of deep, well drained, sloping soils on uplands. A moderately well drained soil mapped in a complex is also in this unit. These soils have a loam surface layer and a clay loam or loam subsoil. Slopes are mostly smooth and uniform, but some are short and irregular. Cultivated areas are slightly eroded to moderately eroded.

Most of these soils are moderate in content of organic matter, are medium in fertility, and have high available water capacity. Permeability is moderate in the subsoil and moderate to moderately slow in the underlying material. Runoff is medium, and the hazard of erosion is severe. Controlling erosion is the chief management need. Other management needs are controlling soil blowing, conserving moisture, and maintaining fertility.

These soils are well suited to all crops grown in the county. Wheat, oats, rye, corn, and alfalfa are the main crops.

Stubble mulching, crop residue use, minimum tillage, contour farming, terraces, and grassed waterways help control erosion and soil blowing, conserve moisture, and maintain fertility. If slopes are too irregular for contour farming and terracing, row crops should be planted infrequently, and the cropping system should make maximum use of close-sown crops, grasses, and legumes.

CAPABILITY UNIT IIIe–2

This unit consists of deep, well-drained, undulating soils on uplands. A moderately well drained soil mapped in the complexes is also in this unit. These soils have a loam surface layer and a clay loam subsoil. Slopes are mostly short and irregular. Cultivated fields are slightly eroded to moderately eroded.

Most of these soils are moderate in content of organic matter, are medium in fertility, and have high available water capacity. Runoff is medium, and the hazard of erosion is severe. Runoff collects on the moderately well drained soil. In some years spring planting is temporarily delayed because of wetness. Controlling erosion is the chief management need. Other important management needs are controlling soil blowing, conserving moisture, and maintaining tilth.

These soils are well suited to all crops grown in the county. Wheat, oats, rye, corn, and alfalfa are the main crops. The soils are less suited to corn and other row crops than to small grain because of the hazard of erosion.

Stubble mulching, crop residue use, minimum tillage, and grassed waterways help control erosion and soil blowing, conserve moisture, and maintain fertility. Limiting the use of row crops and using close-sown crops, grasses, and legumes in the cropping system also help control erosion. Slopes are too irregular in most areas for contour farming and terraces.

CAPABILITY UNIT IIIe–3

This unit consists of deep, well drained and moderately well drained, nearly level to gently sloping soils on uplands. These soils have a surface layer of silty clay loam and loam and a subsoil of firm silty clay and clay loam.

These soils are moderate to high in content of organic matter, are medium to low in fertility, and have high available water capacity. Permeability is moderately slow or slow, and runoff is slow to medium. These soils are subject to erosion and soil blowing. The clayey subsoil releases moisture slowly to plants. Some of the soils have a claypan subsoil that is especially restrictive to the movement of air, water, and roots. Controlling erosion and soil blowing, improving water intake and tilth, and conserving moisture are the chief management needs.

Some of these soils are well suited to all crops grown in the county, but the claypan soils are better suited to small grain, grasses, and legumes than to corn.

Stubble mulching, crop residue use, contour farming, and terraces help control erosion and conserve moisture. Wind stripcropping helps control soil blowing. Grasses and legumes in the cropping system, green manure crops, application of manures, timely tillage, and chiseling or subsoiling help improve water intake and tilth and maintain fertility.

CAPABILITY UNIT IIIe–6

Bowdle loam, 2 to 6 percent slopes, is the only soil in this unit. It is a well-drained, gently sloping soil that is moderately deep to sand and gravel.

This soil is moderate to high in content of organic matter, is medium in fertility, has low or moderate available water capacity, and is somewhat droughty. Runoff is medium, and there is a moderate hazard of erosion. Controlling erosion and conserving moisture are the chief management needs. Other management needs are controlling soil blowing and maintaining fertility.

Wheat, oats, rye, corn, and alfalfa are the main crops grown, but this soil is better suited to such early maturing crops as small grain.

Stubble mulching, crop residue use, minimum tillage, and contour farming help control erosion and soil blowing and also conserve moisture. Terraces also help control erosion and conserve moisture, but the moderate depth to sand and gravel limits channel cuts to less than 20 inches.

CAPABILITY UNIT IIIe–8

Tally fine sandy loam, 2 to 6 percent slopes, is the only soil in this unit. It is a deep, well-drained, gently undulating soil on uplands. It has a subsoil of very friable sandy loam.

This soil is moderate in content of organic matter, is medium in fertility, and has low or moderate available water capacity. Permeability is moderately rapid, and runoff is slow. This soil is easy to work, but it blows easily and is somewhat droughty. There is also a slight hazard of erosion. Controlling soil blowing and conserving moisture are the chief management needs. Other management needs are controlling erosion and maintaining fertility and content of organic matter.

This soil is suited to all crops grown in the county, but in dry years it is better suited to small grain than to corn.

Stubble mulching, crop residue use, minimum tillage, wind stripcropping, and field windbreaks help control soil blowing and erosion and conserve moisture. Crop residue use, grasses, and legumes in the cropping system, and animal manures help maintain content of organic matter and fertility.

CAPABILITY UNIT IIIe–1

The Niobell soil in Niobell-Miranda loams, 0 to 3 percent slopes, is the only soil in this unit. It is a deep, moderately well drained, nearly level soil. This soil has a loam surface layer and a claypan subsoil of firm, clay loam.

This soil is moderate in content of organic matter, is medium in fertility, and has high available water capacity. Runoff is slow. The claypan soil takes in water slowly and releases it slowly to plants. Shortage of moisture occurs late in summer. Improving water intake and conserving moisture are the chief management needs. Other important management needs are controlling soil blowing and maintaining fertility and tilth.

Many areas are cultivated. This soil is better suited to small grain and alfalfa than to corn.

Stubble mulching, crop residue use, timely tillage, chiseling or subsoiling, and grasses and legumes in the cropping system help improve water intake and conserve moisture. They also help control soil blowing and maintain fertility and tilth.

CAPABILITY UNIT IIIs–2

This unit consists of well drained to somewhat poorly drained, nearly level soils that are moderately deep to sand and gravel or sand. These soils have a loam surface layer and a friable loam subsoil.

These soils are moderate or high in content of organic matter, medium in fertility, and have low or moderate available water capacity. Permeability is moderate in the subsoil and is rapid in the underlying material. Runoff is slow. In some years fieldwork is delayed on the moderately well drained to somewhat poorly drained soil by a seasonal water table, but all these soils are somewhat droughty in dry years because they are underlain by sand and gravel. Conserving moisture is the chief management need. Other important management needs are controlling soil blowing and maintaining fertility.

These soils are suited to all crops grown in the county, but in dry years they are better suited to early maturing crops than to corn.

Stubble mulching, crop residue use, minimum tillage, and wind stripcropping help conserve moisture and control soil blowing.

CAPABILITY UNIT IIIs–4

Divide loam is the only soil in this unit. It is a moderately well drained to somewhat poorly drained, nearly level, calcareous soil that is moderately deep to sand and gravel.

This soil is moderate in content of organic matter, is medium in fertility, and has low or moderate available water capacity. Permeability is moderate in the soil above the sand and gravel and is rapid in the sand and gravel. Runoff is slow. In the spring wetness from a seasonal water table delays fieldwork, but the water table recedes in the summer, and in dry years this soil is somewhat droughty. The high content of lime causes this soil to blow easily and also affects the availability of plant nutrients. Controlling soil blowing, conserving moisture, and maintaining fertility are the chief management needs.

This soil is suited to all crops grown in the county, but in dry years it is better suited to early maturing crops than to corn.

Stubble mulching, crop residue use, minimum tillage, wind stripcropping, and field windbreaks help control soil blowing, conserve moisture, and maintain fertility.

CAPABILITY UNIT IVe–1

The Williams part of Vida-Williams loams, 6 to 15 percent slopes, is the only soil in this unit. It is a deep, well drained, undulating to rolling soil on uplands. The subsoil is clay loam. Slopes are mostly short and irregular. Cultivated areas are slightly eroded to moderately eroded.

This soil is moderate in content of organic matter, is medium in fertility, and has high available water capacity. Permeability is moderate in the subsoil and moderately slow in the underlying material. Runoff is medium, and the hazard of erosion is severe. Controlling erosion is the chief management need. Other management needs are controlling soil blowing, conserving moisture, and maintaining fertility.

Many areas are cultivated. This soil is better suited to close-sown crops than to other crops because of the hazard of erosion.

Stubble mulching, crop residue use, minimum tillage, and use of close-sown crops in the cropping system help control erosion and soil blowing and conserve moisture. In most areas, slopes are too short and irregular for contour farming and terraces. Use of grasses and legumes in the cropping system helps maintain fertility and content of organic matter.

CAPABILITY UNIT IVe–5

The Bowdle part of Wabek-Bowdle loams, 6 to 15 percent slopes, is the only soil in this unit. It is a well-drained, undulating soil that is moderately deep to sand and gravel. Slopes are short and irregular.

This soil is moderate to high in content of organic matter, is medium in fertility, and has low or moderate available water capacity. Permeability is moderate in the subsoil and is rapid in the underlying sand and gravel. Runoff is medium, and the hazard of erosion is severe. Controlling erosion and soil blowing and conserving moisture are the chief management needs.

This soil is better suited to early maturing, close-sown crops than to other crops. In some areas where the pattern of this soil with Wabek soils makes cultivation impractical, this Bowdle soil is better suited to native grass.

Stubble mulching, crop residue use, minimum tillage, and use of close-sown crops help control erosion and soil blowing and conserve moisture.

CAPABILITY UNIT IVe–6

This unit consists of well drained to somewhat poorly drained, gently sloping and gently undulating soils that are mostly shallow to sand and gravel. A soil that is moderately deep to sand and gravel is in some areas. These soils have a loam surface layer and a friable loam subsoil. Some slopes are long and smooth; others are short and convex. In some places the soils are nearly level.

Most of these soils are moderate in content of organic matter, are low in fertility, and have low available water capacity. Permeability is moderately rapid in the subsoil and is rapid in the underlying sand and gravel. Runoff is medium. Controlling erosion and soil blowing and conserving moisture are the chief management needs. Another management need is improving fertility and content of organic matter.

These soils are too droughty for corn and other late maturing crops. They are better suited to such early maturing crops as oats and rye.

Stubble mulching, crop residue use, minimum tillage, and contour farming help control erosion and soil blowing and conserve moisture. The shallow depth to sand and gravel limits the use of terraces. Wind stripcropping helps control soil blowing. Use of animal manures helps improve fertility and organic-matter content.

CAPABILITY UNIT IVe-13

Letcher fine sandy loam is the only soil in this unit. It is a deep, moderately well drained to somewhat poorly drained, nearly level soil. It has a surface layer of fine sandy loam and sandy loam and a subsoil of sandy loam.

This soil is moderate in content of organic matter, is medium in fertility, and has moderate available water capacity. The subsoil takes in water slowly and releases it slowly to plants. Runoff is slow. This soil is easy to work, but the hazard of soil blowing is severe. Controlling soil blowing and improving water intake are the chief management needs. Other important management needs are conserving moisture and maintaining fertility and organic-matter content.

Many areas of this soil are still in native grass. Some areas are cultivated. This soil is better suited to small grain and alfalfa than to other crops.

Stubble mulching, crop residue use, minimum tillage, and wind stripcropping help control soil blowing and conserve moisture. Chiseling or subsoiling helps improve water intake in the subsoil. Use of grasses and legumes in the cropping system, green manure crops, and animal manures helps maintain or improve fertility and content of organic matter.

CAPABILITY UNIT IVw-1

This unit consists of deep, poorly drained, level soils in closed depressions on uplands. These soils have a silt loam surface layer and the subsoil is clay or silty clay.

These soils are moderate to moderately low in content of organic matter, are medium in fertility, and have high available water capacity. Permeability is slow, and runoff is ponded. Drainage improvement structures are not feasible, and in wet years the ponded water remains on the soil surface. Fieldwork is delayed in most years and crops are drowned in some years by ponded water. Wetness is the chief concern of management. Other management needs are improving water intake and maintaining tilth and fertility.

Most areas are still in native grass, but a few areas are cultivated. The soils are better suited to such late planted crops as sorghum, millet, and sudangrass than to small grain, corn, and alfalfa.

Controlling runoff from adjacent soils helps reduce wetness. Crop residue use and timely tillage help maintain tilth and fertility.

CAPABILITY UNIT IVs-1

Lehr loam, 0 to 3 percent slopes, is the only soil in this unit. It is a well drained to somewhat excessively drained, nearly level soil that is shallow to sand and gravel. The surface layer and subsoil are loam.

This soil is moderate in content of organic matter, is low in fertility, and has low available water capacity. Permeability is moderately rapid in the subsoil and rapid in the underlying sand and gravel. Runoff is slow. This soil is droughty, and there is a moderate hazard of soil blowing. Conserving moisture and controlling soil blowing are the chief management needs. Another management need is improving fertility and content of organic matter.

This soil is too droughty for late maturing crops such as corn. It is better suited to early maturing small grain.

Stubble mulching, crop residue use, minimum tillage, and wind stripcropping help conserve moisture and control soil blowing. Use of animal manures helps improve fertility and content of organic matter.

CAPABILITY UNIT Vw-4

This unit consists of deep, very poorly drained, level and nearly level soils on bottom land and in closed depressions on uplands. These soils have a surface layer of silt loam or silty clay loam and a subsoil of silt loam and silty clay.

These soils are moderately low to high in content of organic matter, are low to medium in fertility, and have moderate or high available water capacity. Runoff is slow to ponded. These soils are wet during much of the growing season because of a high water table and ponded water.

Most areas are still in native vegetation and are used for grazing, hay, and wildlife habitat. Haying commonly is delayed until late summer because of wetness.

Controlling runoff from adjacent soils helps reduce wetness. Drainage improvement structures generally are not feasible because there are no outlets.

CAPABILITY UNIT VIe-1

Edgeley loam, 6 to 20 percent slopes, is the only soil in this unit. It is a moderately deep, well drained, sloping to moderately steep loamy soil on uplands. The subsoil is friable loam and clay loam and is underlain by soft shale at a depth of 34 inches.

This soil has low or moderate available water capacity. Permeability is moderate in the subsoil and is slow in the underlying material. Runoff is medium, and the hazard of erosion is severe. This soil is too steep and erodible for cultivation.

Most of the areas are still in native grass and are used for grazing. Proper grazing use helps control erosion. Stubble mulching and minimum tillage help control erosion in cultivated areas until they are seeded to grass.

CAPABILITY UNIT VIe-3

This unit consists of deep, well drained to excessively drained, undulating to hilly soils on uplands. These soils have a loam surface layer over clay loam.

These soils are moderate to low in content of organic matter, are medium to low in fertility, and have high available water capacity. Some are calcareous and are low in fertility. Runoff is medium to rapid, and the hazard of erosion is very severe. These soils are too steep and erodible for cultivation.

Most areas are still in native grass and are used for grazing. Proper grazing use helps control erosion. Stubble mulching and minimum tillage help control erosion in cultivated areas until they are seeded to grass.

CAPABILITY UNIT VIw-3

This unit consists of Loamy Fluvaquents. These are deep, somewhat poorly drained, nearly level soils on bottom land. Most of these mixed alluvial soils have a surface layer of loam or silt loam underlain by stratified alluvium ranging from fine sandy loam to clay loam.

The narrow areas are dissected by meandering channels.

These soils are subject to flooding. The meandering channels make cultivation impractical in most areas.

Most areas are still in native vegetation and are used for grazing, hay, and wildlife habitat.

CAPABILITY UNIT VIw–4

Ranslo-Harriet silt loams are the only soils in this unit. They are deep, somewhat poorly drained and poorly drained, nearly level soils on bottom land. These soils have a claypan subsoil. The surface layer is silt loam and the subsoil is silty clay loam or silty clay.

These soils have a high water table and are subject to flooding. The claypan subsoil releases moisture slowly to plants. In places there are accumulations of salts in the lower part of the subsoil. In most areas these soils are not suited to cultivation.

Most areas are still in native grass and are used for grazing and hay. Uneven surfaces in some areas make haying difficult.

CAPABILITY UNIT VIs–1

This unit consists of deep, poorly drained to moderately well drained, level and nearly level soils in closed depressions and low areas on uplands. These soils have a claypan subsoil. They have a thin surface layer of silt loam or loam and a subsoil of clay or clay loam.

These soils take in water very slowly and release it slowly to plants. Runoff is slow to ponded. Water stays on the surface of ponded areas until it evaporates. These soils are wet early in the growing season but are dry and very hard to extremely hard late in summer. Tilth is very poor in cultivated areas. These soils are not suited to cultivation.

Most areas are still in native grass and are used for grazing and hay.

CAPABILITY UNIT VIIs–4

This unit consists of excessively drained, undulating to hilly soils that are very shallow to sand and gravel. These soils have a thin surface layer of loam.

These soils are moderately low in content of organic matter and are low in fertility. Available water capacity is low or very low. Runoff is slow, but disturbed areas are subject to erosion and soil blowing. These soils are too droughty for cultivation.

Some areas are cultivated, and some are still in native grass and are used for grazing. Wheat, oats, and rye are the main crops in cultivated areas.

Stubble mulching, crop residue use, and minimum tillage help control erosion and soil blowing and conserve moisture in cultivated areas until they are seeded to grass.

CAPABILITY UNIT VIIs–6

Vida stony loam, 3 to 15 percent slopes, is the only soil in this unit. It is a deep, well drained, gently undulating to rolling soil on uplands. The surface layer is stony loam and the subsoil is clay loam. Stones and boulders are scattered on the surface.

This soil is moderate in content of organic matter, is medium in fertility, and has high available water capacity. Permeability is moderate in the subsoil and moderately slow in the underlying material. Runoff is medium, and the hazard of erosion is moderate to severe. This soil is too stony for cultivation or for use of haying machinery.

All areas are still in native grass and are used for grazing.

CAPABILITY UNIT VIIIw–1

This unit consists of Marsh. These areas are covered by shallow water during most years. Some areas contain open water surrounded by cattails, bulrushes, and reeds, and some areas are covered entirely by coarse aquatic plants. Marsh has little or no value for farming and grazing, but it is excellent for wildlife habitat.

Predicted yields

Table 2 lists the predicted average yields per acre of corn, oats, spring wheat, rye, and alfalfa for each soil judged suitable for crops. The predictions are for dry-farmed soils under two levels of management.

Yield predictions shown in column A of table 2 are those that can be expected under management that is customarily practiced in the county. Conservation crop rotations are lacking or are poorly planned, barnyard manure or green-manure crops are not extensively used, sloping soils are farmed up and down hill, the poorer soils are farmed along with the better soils, and commercial fertilizers are not used regularly as needed.

The predicted yields shown in column B are those that can be expected under careful and intensive management, which includes use of recommended conservation cropping systems; application of needed mechanical conservation practices; use of commercial fertilizers in kinds and amounts recommended by soil tests and the kind of crop to be grown; effective control of weeds; and the use of barnyard manure, green-manure crops, and legumes and grasses to maintain organic-matter content and improve soil fertility and tilth.

The yield predictions in table 2 are based on information supplied by representative farmers thoughout the county, by the county agricultural extension agent, by the South Dakota Crop and Livestock Reporting Service, and by Soil Conservation Service personnel in Edmunds County. Yields are based on planted acres rather than harvested acres and are averaged out to include years of below-normal and above-normal precipitation. These predicted yields are subject to change as crop varieties and farming methods improve.

Tame Pasture[4]

Tame pasture is a practical and economically feasible use for most of the soils in the county. Tame pastures supplement the grazing provided by native pastures or range. The main objectives of pasture management are to maintain vigorous stands of palatable forage for livestock feed, to improve the soil, and to control erosion and soil blowing.

Proper grazing, use of fertilizers, clipping, and weed

[4] By PAUL M. BODEN, conservation agronomist, Soil Conservation Service.

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

[Figures in columns A are the yields to be expected under prevailing management; those in columns B can be expected under improved management. Absence of a figure indicates the crop is not commonly grown on the soil or the soil is not suitable for that crop. Only soils suitable for crops are listed. Yields for soil complexes are based on the weighted average yields of the soils in the complex]

Soil	Corn		Oats		Spring wheat		Rye		Alfalfa	
	A	B	A	B	A	B	A	B	A	B
	Bu	*Bu*	*Bu*	*Bu*	*Bu*	*Bu*	*Bu*	*Bu*	*Tons*	*Tons*
Bearden loam	35	49	44	62	20	28	34	44	1.7	2.5
Bowbells-Cresbard loams	34	49	43	63	21	30	32	42	1.6	2.4
Bowdle loam, 0 to 2 percent slopes	21	30	33	44	15	21	20	30	.8	1.2
Bowdle loam, 2 to 6 percent slopes	19	28	31	41	13	19	18	28	.7	1.1
Bryant loam, 0 to 2 percent slopes	26	35	39	53	21	28	30	40	1.4	2.0
Bryant loam, 2 to 6 percent slopes	24	32	37	52	20	27	28	38	1.4	1.9
Bryant loam, 6 to 9 percent slopes	22	30	33	44	17	22	22	30	1.2	1.6
Bryant loam, sandy substratum, 1 to 3 percent slopes	20	29	31	42	15	21	20	30	.9	1.3
Bryant-Grassna loams, 2 to 6 percent slopes	27	36	39	57	20	27	30	40	1.6	2.3
Divide loam	24	34	29	45	14	23	24	34	1.3	2.1
Grassna loam	36	51	45	68	22	31	34	44	2.0	3.1
Lehr loam, 0 to 3 percent slopes			24	37	12	17	15	23	.7	1.1
Lehr loam, 3 to 6 percent slopes			22	35	11	15	14	21	.6	1.0
Lehr-Bowdle loams, 0 to 6 percent slopes			26	40	12	18	18	26	.7	1.1
Letcher fine sandy loam			20	30			16	23	1.0	1.4
Mondamin silty clay loam, 0 to 2 percent slopes	28	38	43	57	17	25	30	40	1.4	2.0
Mondamin silty clay loam, 2 to 6 percent slopes	26	37	41	54	15	23	28	38	1.4	1.9
Mondamin-Heil silty clay loams	20	28	33	44	14	19	20	30	1.1	1.5
Niobell-Miranda loams, 0 to 3 percent slopes			26	35	10	14	15	21	.7	1.0
Niobell-Noonan loams, 1 to 5 percent slopes	18	26	29	41	13	18	18	25	1.0	1.4
Spottswood loam	28	38	33	48	16	24	24	34	1.6	2.2
Tally fine sandy loam, 2 to 6 percent slopes	29	40	26	44	12	17	22	32	1.1	1.5
Temvik-Bryant loams, 2 to 6 percent slopes	23	31	37	52	19	25	26	36	1.4	1.9
Temvik-Grassna loams, 3 to 6 percent slopes	27	39	39	59	20	26	28	38	1.6	2.4
Temvik-Grassna loams, 6 to 9 percent slopes	23	32	36	52	16	22	25	35	1.5	2.1
Tonka-Nishon silt loams			25	50		25				2.3
Vida-Williams loams, 6 to 15 percent slopes	16	28	27	42	12	18	14	22	1.1	1.5
Wabek-Bowdle loams, 6 to 15 percent slopes			20	30	9	12	14	18	.5	.7
Williams-Bowbells loams, 3 to 6 percent slopes	26	— 39	39	57	19	26	27	37	1.5	2.1
Williams-Bowbells loams, 6 to 9 percent slopes	24	35	36	53	16	23	22	30	1.4	1.9
Williams-Bowbells-Nishon complex, 0 to 2 percent slopes	25	38	38	56	19	27	26	35	1.6	2.2
Williams-Bowbells-Nishon complex, 2 to 6 percent slopes	24	36	36	53	18	26	24	34	1.5	2.1
Williams-Bowbells-Parnell complex, 6 to 9 percent slopes	21	32	32	50	14	21	18	26	1.2	1.8

control help meet the objectives of pasture management. Proper grazing includes delaying grazing until the pasture plants have a good growth in the spring, never grazing too closely, rotation grazing, grazing at the time of optimum growth, and periodic resting. Applying chemical fertilizers as indicated by soil tests helps maintain an adequate supply of plant nutrients to support a vigorous growth. Clipping stimulates even regrowth and encourages uniform grazing. Control of weeds by mowing or spraying results in more moisture and plant nutrients for desirable pasture plants.

Soils that produce about the same kind and amount of tame grasses and legumes are in the same pasture group, each of which is described in the following paragraphs. Only those soils suited to tame pasture and hayland are assigned to pasture groups. To find the pasture group of a given soil, turn to the "Guide to Mapping Units" at the back of this survey.

PASTURE GROUP A

This group consists of deep, somewhat poorly drained to poorly drained soils in depressions in uplands. These soils receive additional moisture as runoff from adjacent soils or have a high water table within the root zone, or both. Drainage is adequate or has been provided by drainage structures, so that plant growth is not adversely affected by wetness. This group is suited to all climatically adapted grasses and legumes, but is better suited to plants that utilize the abundant moisture.

Grasses and legumes suited to this group are alfalfa, big bluestem, creeping foxtail, green needlegrass,

indiangrass, intermediate wheatgrass, reed canarygrass, smooth bromegrass, and switchgrass.

PASTURE GROUP B

This group consists of somewhat poorly drained to very poorly drained soils in bottom land and in depressions in uplands. These soils are wet throughout much of the growing season in most years because of a high water table or ponded runoff water or both. Drainage is not adequate and artificial drainage is not feasible. The choice of plants is limited to water-tolerant species.

Pasture plants suited to this group are creeping foxtail, reed canarygrass, and western wheatgrass.

PASTURE GROUP C

The Noonan part of Niobell-Noonan loams, 1 to 5 percent slopes, is the only soil in this group. It is a deep, moderately well drained, nearly level to gently sloping soil that has a claypan subsoil. Permeability is slow in the claypan subsoil. Salts commonly are in the lower part of the subsoil and in the underlying material. The claypan subsoil releases moisture slowly to plants and restricts the development of plant roots. Choice of plants and production are limited by the unfavorable root zone.

Grasses and legumes suited to this group are alfalfa, crested wheatgrass, green needlegrass, intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and western wheatgrass.

PASTURE GROUP D

This group consists of loamy soils that are moderately deep and shallow to sand and gravel or to sand. Most of these soils are well drained to somewhat excessively drained, but some are moderately well drained to somewhat poorly drained because of a seasonal water table. Permeability is rapid in the underlying material, and available water capacity is low or moderate. All of these soils are droughty during late summer in most years. Choice of plants and production are limited by shortage of moisture in most years.

Grasses and legumes suited to this group are alfalfa, crested wheatgrass, green needlegrass, intermediate wheatgrass, pubescent wheatgrass, and smooth bromegrass. The soils in this group that are shallow to sand and gravel are better suited to crested wheatgrass and pubescent wheatgrass than to the other species listed.

PASTURE GROUP E

This group consists of deep, moderately well drained, nearly level to gently sloping loamy soils that have a moderately thick to thick surface layer over a claypan subsoil. The claypan subsoil has slow or moderately slow permeability and releases moisture slowly to plants. Choice of plants and production are limited by the somewhat unfavorable root zone.

Grasses and legumes suited to this group are alfalfa, crested wheatgrass, green needlegrass, intermediate wheatgrass, and smooth bromegrass.

PASTURE GROUP F

This group consists of deep and moderately deep, nearly level to hilly loamy soils in uplands. Most of these soils are well drained, but some are somewhat poorly drained. Most of the soils have moderate permeability in the subsoil and have moderate or high available water capacity. All climatically adapted pasture plants are suited to the soils in this group, but bunch type species should not be planted alone on soils where slopes are 6 percent or more.

Grasses and legumes suited to this group are alfalfa, crested wheatgrass, green needlegrass, intermediate wheatgrass, pubescent wheatgrass, and smooth bromegrass. Big bluestem, indiangrass, and switchgrass can be used with the above species on some of the soils in the eastern part of the county.

PASTURE GROUP G

The Zahill part of Vida-Zahill loams, 15 to 25 percent slopes, is the only soil in this group. It is a deep, excessively drained, hilly loamy soil in uplands. The surface layer is thin and the soil is calcareous at or near the surface. Available water capacity is high, but runoff is rapid. Choice of plants and production are limited by low fertility, high content of lime, and by the severe hazard of erosion.

Grasses and legumes suited to this group are alfalfa, crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, and smooth bromegrass. Bunch grasses should not be planted alone because of the severe hazard of erosion.

PASTURE GROUP H

This group consists of deep, well drained to somewhat poorly drained loamy soils that have a surface layer and subsoil of fine sandy loam and sandy loam. These soils take in water readily, but have low or moderate available water capacity and are subject to soil blowing. Choice of plants is affected by available water capacity and the severe hazard of soil blowing.

Grasses and legumes suited to this group are alfalfa, crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, sand bluestem, and smooth bromegrass. Big bluestem, indiangrass, and switchgrass also can be planted on the moderately well drained to somewhat poorly drained soil.

PASTURE GROUP I

This group consists of deep, well drained to moderately well drained, nearly level to gently sloping soils that have a subsoil of silty clay. These soils have high available water capacity, but the silty clay loam surface layer takes in water slowly and the silty clay subsoil releases it slowly to plants. Choice of plants and production are somewhat limited by the clayey root zone.

Grasses and legumes suited to this group are alfalfa, crested wheatgrass, green needlegrass, intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and western wheatgrass.

PASTURE GROUP J

This group consists of deep, poorly drained and very poorly drained soils in bottom land. These soils have a water table that is near the surface during the growing season. Some of these soils have a claypan and contain accumulations of salts in the subsoil. Some have a high content of lime at shallow depths. Wetness and the high content of salts or lime limit the choice of pasture plants.

The main grass species suited to this group are tall wheatgrass and western wheatgrass.

PASTURE GROUP K

This group consists of deep, moderately well drained, loamy soils in swales in uplands. These soils have moderate permeability in the subsoil, have high available water capacity, and are high in fertility. Additional moisture is received in most years as runoff from adjacent soils. All climatically adapted pasture plants are suited to the soils in this group, and potential production is higher than on adjacent upland soils because of the favorable moisture.

Grasses and legumes suited to this group are alfalfa, big bluestem, green needlegrass, indiangrass, intermediate wheatgrass, smooth bromegrass, switchgrass, and western wheatgrass.

Range [5]

Most of Edmunds County was originally covered by prairie vegetation. As the county was settled, much of this grassland was plowed and farmed. Usually the best soils were cultivated. The soils still in native grass are mostly steep, thin, stony, or wet, or for other reasons are not well suited to cultivation.

Approximately 184,000 acres or about 26 percent of the county is still in native grass. Much of this is in the Williams-Vida association in the western and north-central parts of the county. The slopes of the undulating to hilly soils of this association make them poorly suited to cultivation.

Much of the range in the county has been heavily grazed for a long time. This grazing has caused changes in the plant cover, and it is difficult to appraise the productive potential of range unless range site and range condition techniques are used.

A *range site* is a distinctive kind of range that differs from other kinds of range in its potential to produce native plants. It is the product of all environmental factors responsible for its development. In the absence of abnormal disturbance and physical site deterioration, it supports a plant community that differs from that of other range sites in kind or proportion of species, or in total annual yield.

Range condition is the present state of vegetation in relation to the climax or natural potential plant community for that site.

Range condition classes are an expression of the degree to which the plant composition, in percent, has departed from that of the climax plant community of a range site.

Four range condition classes are recognized: excellent, good, fair, and poor. A range is in *excellent* condition if 76 to 100 percent of the vegetation is that of the climax vegetation for that site. It is in *good* condition if the percentage is 51 through 75; in *fair* condition if the percentage is 26 through 50; and *poor* condition if the percentage is 25 or less.

Determining range condition provides a basis for predicting the nature and direction of plant community changes that can be expected from management and treatment.

[5] By THOMAS H. POZARNSKY, range conservationist, Soil Conservation Service.

The range condition of a range site is determined by comparing present vegetation with the climax plant community as indicated by the range condition guide for the site. Components of the plant community are grouped according to their response to grazing on specific range sites. These groups are decreaser, increaser, and invader plants.

Decreaser plants are species in the climax plant community that decrease in abundance when subject to continued excessive grazing. *Increaser plants* are species in the climax plant community that increase in abundance when subject to continued excessive grazing. *Invader plants* are not members of the climax plant community for the site. They invade the community as a result of disturbances.

The range sites of Edmunds County are described in the following paragraphs. The important characteristics and properties of the soils in each site, the principal plants in the plant community, and estimates of forage yield are all given. The yield estimates are for the sites in excellent condition and are for the entire annual growth. Of this total annual yield, 70 to 90 percent are grass species that provide forage for cattle.

Boundaries of range sites can be determined from the soil maps in this soil survey. The range site in which a soil is placed and the page on which it is described can be found in the "Guide to Mapping Units" at the back of this survey.

WETLAND RANGE SITE

This site consists of deep, very poorly drained soils in closed depressions and on bottom land. The water table is high during much of the growing season. Grass species on this site are limited by wetness and poor aeration. The soils are too wet and too poorly aerated to grow big bluestem, but have the potential to produce a luxuriant stand of water-tolerant grasses.

Prairie cordgrass, reedgrass, reed canarygrass, and rivergrass are the main species. In places slough sedge is about 25 percent of the vegetation. Shrubs and trees, such as indigobush amorpha and willows, are in some areas.

Under continued heavy grazing the climax grasses lose vigor and thin out. Sedges and rushes then increase in abundance. Because the increaser species are either shorter or less palatable to livestock than the climax species, production declines.

Mechanical treatment for range improvement is not feasible. Range seeding is very difficult because of wetness.

If this site is in excellent condition, the total annual production of air-dry herbage per acre ranges from 5,500 pounds in unfavorable years to 6,500 in favorable years.

SUBIRRIGATED RANGE SITE

The Ranslo part of Ranslo-Harriet silt loams is the only soil in this site. It is a deep, somewhat poorly drained soil on bottom land. This soil has a beneficial water table that is within a depth of 4 feet for most of the growing season. The water table is at the surface during the spring in some years, but only for a very short period. This site is not too wet or too poorly aerated to grow big bluestem and has the potential to produce a luxuriant stand of tall prairie grasses.

Big bluestem is the dominant grass on this site and is 75 to 90 percent of the vegetation in some areas. Other tall grasses are switchgrass, indiangrass, Canada wildrye, and prairie cordgrass. Western wheatgrass and inland saltgrass are increasers that are present in small amounts. Kentucky bluegrass, sedges, and forbs are in some areas. Indigobush amorpha is a conspicuous shrub in places.

Under continued heavy grazing the climax grasses lose vigor and thin out. Western wheatgrass, inland saltgrass, and Kentucky bluegrass then increase in abundance. If overgrazing is prolonged, Kentucky bluegrass, inland saltgrass, or foxtail barley with an overstory of unpalatable weeds become dominant.

Mechanical treatment, such as contour furrowing and pitting, is not feasible on this range site.

If this site is in excellent condition, the total annual production of air-dry herbage per acre ranges from 3,520 pounds in unfavorable years to 4,840 in favorable years.

OVERFLOW RANGE SITE

This site consists of deep, moderately well drained to somewhat poorly drained soils on bottom land and in swales on upland. These soils regularly receive additional moisture in the form of flooding from stream overflow or runoff from adjacent sloping soils. The additional moisture gives this site a potential of producing dense stands of tall grasses.

Big bluestem is the dominant grass in the climax plant cover and in places is 45 to 65 percent of the vegetation. In a few places green needlegrass and porcupinegrass are abundant, but they do not dominate the site. Switchgrass, Canada wildrye, and little bluestem are other decreasers. The principal increasers are western wheatgrass and side-oats grama. Also in the understory are Kentucky bluegrass, sedges, and forbs. Scattered plants of leadplant amorpha are conspicuous in some areas.

Under continued heavy grazing the climax grasses lose vigor and thin out. Western wheatgrass and Kentucky bluegrass then increase in abundance. If overgrazing is prolonged, Kentucky bluegrass becomes dominant.

If this site is in excellent condition, the total annual production of air-dry herbage per acre ranges from 3,000 pounds in unfavorable years to 4,000 pounds in favorable years.

SALINE LOWLAND RANGE SITE

The Harriet part of Ranslo-Harriet silt loams is the only soil in this site. It is a deep, poorly drained soil on bottom land. The water table is within a depth of 5 feet during much of the growing season. There are soluble salts in the subsoil that affect the kind of vegetation that will grow on the site.

The climax plant cover is made up of tall, salt-tolerant grasses. Alkali or prairie cordgrass is the dominant grass. Other tall grasses are switchgrass and alkali sacaton. Other decreasers are the mid grasses, western wheatgrass and Nuttall alkaligrass. Inland saltgrass, an increaser, sedges, and forbs occur in small amounts.

Under continued heavy grazing the climax grasses lose vigor and thin out. They are replaced by inland saltgrass.

If this site is in excellent condition, the total annual production of air-dry herbage per acre ranges from 2,800 pounds in unfavorable years to 3,850 pounds in favorable years.

CLOSED DEPRESSION RANGE SITE

This site consists of deep, poorly drained soils in closed depressions in uplands. The subsoils are clay or silty clay, and permeability is slow or very slow. Runoff is ponded, and the soils are wet until late spring or mid summer. In dry periods the clayey subsoils release moisture slowly to plants, and the soils in this site are droughty.

The potential plant cover lacks the stability normally associated with climax plant cover because of the alternating wetness and dryness. In some areas the best vegetative cover is a mixture of tall and mid grasses and sedges. In many areas the only vegetation is western wheatgrass and a small amount of sedge.

Under continued heavy grazing, western wheatgrass is replaced by short grasses or sedges. Sedges and rushes increase during wet periods. Buffalograss becomes more abundant during extended dry periods. If this site is grazed when wet, less desirable vegetation increases. Foxtail barley, smartweed, and annual weeds dominate the site in poor condition.

If this site is in excellent condition, the total annual production of air-dry herbage per acre ranges from 2,300 pounds in unfavorable years to 3,800 pounds in favorable years.

SANDY RANGE SITE

This site consists of deep, well drained to somewhat poorly drained soils in uplands. These soils have a surface layer and subsoil of fine sandy loam and sandy loam. Most take in water readily and release it to plants easily, although some soils in this site take in water slowly and release it slowly to plants. Runoff is slow.

The climax plant cover is mainly a mixture of mid and tall warm season grasses. Little bluestem, big bluestem, and prairie sandreed are the main species. Needleandthread and western wheatgrass are cool season increasers that are next in importance. Canada wildrye and prairie junegrass are cool season decreasers that occur in small amounts. Small amounts of blue grama, side-oats grama, and forbs are present.

Under continued heavy grazing the bluestem species decrease and are replaced by prairie sandreed, needleandthread, western wheatgrass, and side-oats grama. If overgrazing is prolonged, these species are replaced by blue grama, Kentucky bluegrass, and sedges.

If this site is in excellent condition, the total annual production of air-dry herbage per acre ranges from 1,840 pounds in unfavorable years to 3,240 pounds in favorable years.

SILTY RANGE SITE

Most of the soils in this site are deep, well-drained loamy soils in uplands, but some are moderately well drained to somewhat poorly drained and some are moderately deep to sand and gravel. These soils are

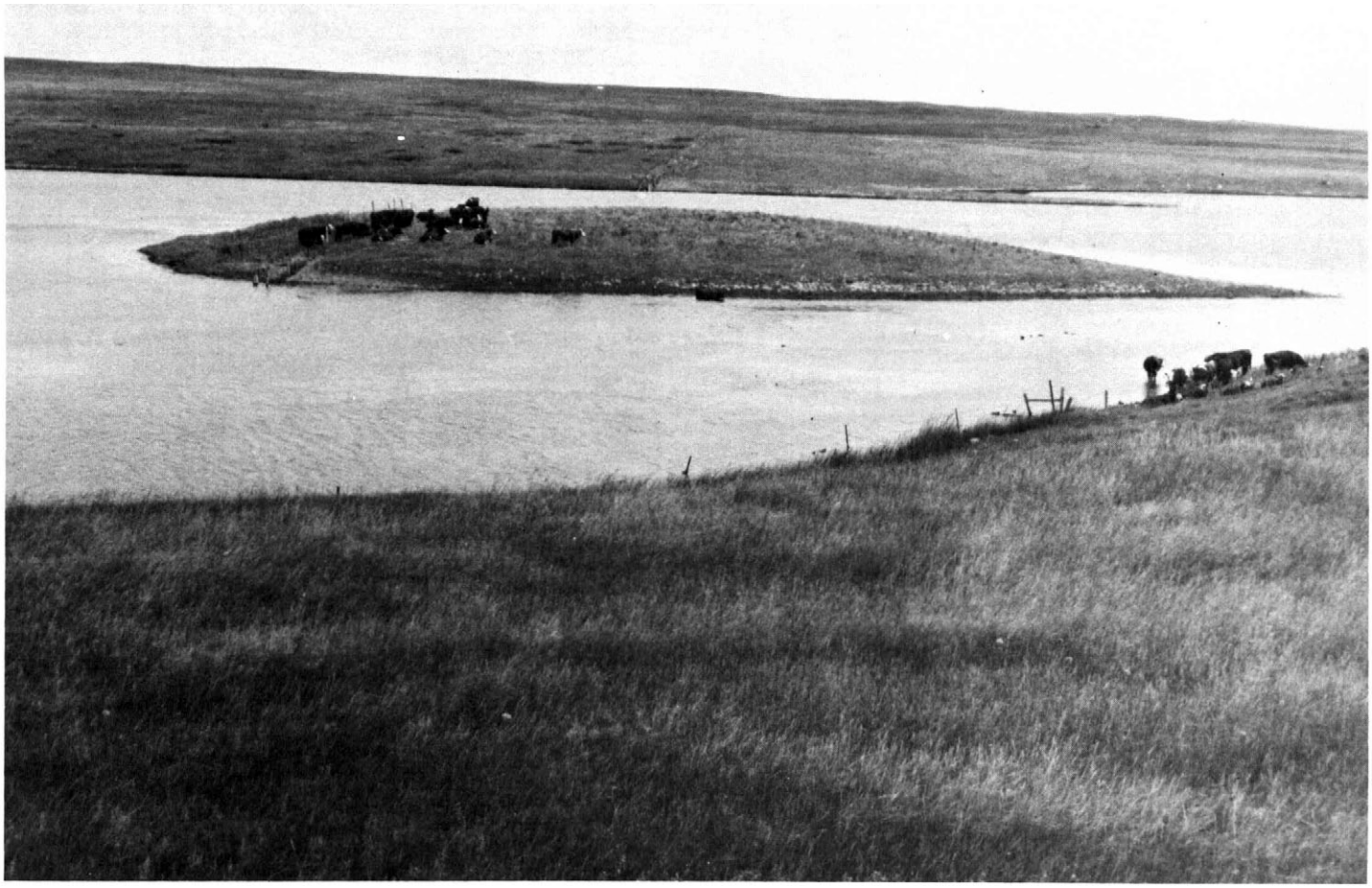


Figure 13.—**Green needlegrass and western wheatgrass are the main grasses in this area of Silty range site. The pond furnishes water for livestock.**

medium or high in fertility and most of them have high or moderate available water capacity.

The climax plant cover is a mixture of tall, mid, and short grasses and is characteristic of areas in transition from true prairie to mixed prairie. Green needlegrass and western wheatgrass are the major grasses (fig. 13). Big bluestem and little bluestem are important warm-season decreasers. Significant amounts of needleandthread, blue grama, and side-oats grama are present. Forbs and woody plants such as leadplant amorpha are not abundant but are an important part of the climax vegetation.

Under continued heavy grazing, the bluestem species and green needlegrass decrease and are replaced by western wheatgrass and needleandthread. If overgrazing is prolonged, western wheatgrass is replaced by blue grama.

If this site is in excellent condition, the total annual production of air-dry herbage per acre ranges from 1,800 pounds in unfavorable years to 3,360 pounds in favorable years.

CLAYEY RANGE SITE

This site consists of deep, moderately well drained and well drained soils in uplands. These soils have a subsoil of clay loam or silty clay. Permeability is slow or moderately slow and the clayey subsoils release moisture slowly to plants.

The climax plant cover is a mixture mainly of mid and short grasses. Western wheatgrass and green needlegrass are the dominant grasses. Big bluestem and little bluestem are warm-season decreasers that occur in small amounts in places. An understory of blue grama and buffalograss is also present. Forbs and woody plants are of little importance.

Under continued heavy grazing, green needlegrass and the bluestem species are replaced by western wheatgrass. If overgrazing is prolonged, western wheatgrass is replaced by short grasses.

If this site is in excellent condition, the total annual production of air-dry herbage per acre ranges from 1,750 pounds in unfavorable years to 3,120 pounds in favorable years.

THIN UPLAND RANGE SITE

The Zahill part of Vida-Zahill loams, 15 to 25 percent slopes, is the only soil in this site. It is a deep, excessively drained, calcareous soil that has a thin surface layer of loam and underlying material of clay loam. Available water capacity is high, but runoff is rapid. This soil is low in fertility and content of organic matter.

Little bluestem is the main species in the climax plant cover. Small amounts of big bluestem and green needlegrass are other decreasers. Blue grama, side-oats grama, needleandthread, and western wheatgrass are the important increasers. Forbs and shrubs, such as leadplant amorpha, are important in places.

Under continued heavy grazing, the bluestem species and green needlegrass are replaced mainly by needleandthread, side-oats grama, and sedges. If overgrazing is prolonged, blue grama and sedges become dominant.

If this site is in excellent condition, the total annual production of air-dry herbage per acre ranges from 1,700 pounds in unfavorable years to 2,500 pounds in favorable years.

CLAYPAN RANGE SITE

The Noonan part of Niobell-Noonan loams, 1 to 5 percent slopes, is the only soil in this site. It is a deep, moderately well drained soil that has a claypan subsoil. The surface layer is loam, and the subsoil is clay loam. This soil has high available water capacity, but permeability is slow. The claypan releases moisture slowly to plants and restricts the development of plant roots.

The climax plant cover is a mixture of mid and short grasses. Western wheatgrass and green needlegrass are the main decreasers. Blue grama is the main increaser.

Under continued heavy grazing, western wheatgrass and green needlegrass are replaced by blue grama. Blue grama then dominates the site during normal periods and is overtopped by weeds during wet cycles.

If this site is in excellent condition, the total annual production of air-dry herbage per acre ranges from 1,400 pounds in unfavorable years to 2,400 pounds in favorable years.

SHALLOW TO GRAVEL RANGE SITE

This site consists of well drained to somewhat excessively drained loamy soils that are shallow over sand and gravel. Available water capacity is low. These soils are droughty.

The climax plant cover is a mixture of mid and short grasses. Needleandthread is the dominant grass. Blue grama, hairy grama, and threadleaf sedge are important short-growing plants. Such forbs as black samson commonly are present.

Under continued heavy grazing, the short grasses become dominant, and a few unpalatable weeds are an overstory.

Mechanical treatments, such as contour furrowing and pitting, are not feasible on this site.

If this site is in excellent condition, the total annual production of air-dry herbage per acre ranges from 1,200 pounds in unfavorable years to 2,100 pounds in favorable years.

THIN CLAYPAN RANGE SITE

This site consists of deep, moderately well drained to poorly drained soils. These soils have a thin surface layer of loam or silty clay loam over a dense claypan subsoil of clay or clay loam. Permeability is very slow and salt accumulations commonly are in the lower part of the subsoil. Growth of plant roots is severely restricted by the claypan subsoil.

The climax plant cover is a mixture of mid and short grasses. Blue grama and western wheatgrass are dominant. Other grasses are needleandthread, buffalograss, and inland saltgrass. Small amounts of pricklypear and other perennial forbs also are present.

Under continued heavy grazing, the mid grasses, western wheatgrass, and needleandthread, are replaced by blue grama, buffalograss, and inland saltgrass. If overgrazing is prolonged, pricklypear and the extent of bare ground increase during dry cycles and weeds increase during wet cycles.

Mechanical treatment for range improvement is not feasible on this site, and the chance for success of range seeding is very poor.

If this site is in excellent condition, the total annual production of air-dry herbage per acre ranges from 840 pounds in unfavorable years to 1,800 pounds in favorable years.

VERY SHALLOW RANGE SITE

This site consists of excessively drained loamy soils that are very shallow over gravel. Permeability is rapid, and available water capacity is very low or low. These soils are very droughty.

The climax plant cover is a mixture of mid and short grasses. Needleandthread is the main mid grass. Blue grama and threadleaf sedge are important short-growing plants.

Under continued heavy grazing, this site rapidly deteriorates to a stand of blue grama and threadleaf sedge. If overgrazing is prolonged, plant cover thins out, and bare areas of the soil are susceptible to soil blowing and erosion.

Mechanical treatment is not feasible on this site. Range seeding is not feasible in the steep areas, and the chance for a successful seeding is very poor in the less steep areas.

If this site is in excellent condition, the total annual production of air-dry herbage per acre ranges from 800 pounds in unfavorable years to 1,500 pounds in favorable years.

Windbreaks[6]

Edmunds County has approximately 300 acres of native woodland. Most of the native trees and shrubs are in clumps and thickets in swales, on flood plains, or in areas adjacent to drainageways and sloughs. There are no major areas of woody vegetation.

The main species of trees and shrubs are American pine, common chokecherry, plains cottonwood, and peachleaf willow. In addition there are several species of wild rose and willow.

The early settlers valued the woody vegetation as a source of fuel and food. Today, the chief use of the native trees and shrubs is for wildlife.

Windbreaks have been planted in Edmunds County since the days of the early settlers. In most areas these plantings were to protect the farmstead and livestock. There is still a need for this kind of planting around many farmsteads. In recent years there has been an increasing interest in planting field windbreaks to help control soil blowing. Thousands of acres in the county still need some form of windbreak protection.

Windbreaks have many economic and environmental

[6] By DAVID L. HINTZ, forester, Soil Conservation Service.

benefits. They distribute and hold snow which prevents it from becoming a problem around the farmstead, and they protect the home and livestock from cold, wintery winds. Windbreaks also reduce fuel and feed costs; protect field crops, gardens, and orchards from damaging winds; reduce evaporation; provide a suitable habitat for many kinds of birds and other wildlife; help control erosion and soil blowing; and enhance the beauty of the rural home and its surroundings.

Before a windbreak is planted, the purpose of the planting, suitability of the soils, adaptability of trees and shrubs, and location of the planting should be considered. Improperly designed windbreaks can cause many problems.

Establishment of a windbreak and continued growth of the trees depend upon the careful selection of the site and upon the tree and shrub species planted. Adequate site preparation before planting and adequate maintenance after planting also are required. Grass and weeds should be eliminated before the trees are planted, and the regrowth of ground cover should be controlled during the life of the windbreak. Some replanting is likely to be needed in the first and second years after the initial planting.

The soils of Edmunds County are grouped into windbreak groups as an aid in determining the suitability of a soil for windbreak plantings. The growth response for adapted trees and shrubs is similar for all soils within a group if good management practices are applied. The most critical factor used in grouping soils for windbreak suitability is the amount and seasonal availability of soil moisture. The soils in some groups have a wide range of slopes, and some differ slightly in the texture of the surface layer. As a result, the soils within a group may differ in their susceptibility to erosion and soil blowing, and also differ in their need for management practices that conserve moisture and control erosion and soil blowing.

Soils that have slopes of 6 percent or more need management practices during site preparation and establishment of the windbreak that will help conserve moisture and control erosion. Soils that have a severe soil blowing hazard need special care during site preparation.

Table 3 lists most of the trees and shrub species used in windbreak plantings. It also gives the actual or estimated height growth of the various species at 20 years of age for each windbreak group except for group 10. Soils in windbreak group 10 are not suited to windbreaks.

The windbreak groups in Edmunds County are described in the following paragraphs. The groups are not numbered consecutively because not all of the groups in the statewide system are present in the county. All soils in the county are in one of the groups except in areas mapped as Marsh. To find the windbreak group for a specific soil, turn to the "Guide to Mapping Units" at the back of this survey.

WINDBREAK GROUP 1

This group consists of moderately well drained to somewhat poorly drained, nearly level to sloping loamy soils in swales and on flats in uplands. Most of these soils are deep and have high available water capacity, but some are moderately deep to sand and gravel and have low or moderate available water capacity. All of these soils have a moisture regime favorable to the growth of trees. Some receive additional moisture as runoff from adjacent soils, and some have a seasonal high water table. The hazard of erosion is slight, but some of the soils are calcareous and are moderately susceptible to soil blowing.

The soils in this group are well suited to all types of windbreaks and other kinds of woody plantings. All climatically adapted species of trees and shrubs have the potential to grow well.

WINDBREAK GROUP 2

The Ranslo part of Ranslo-Harriet silt loams is the only soil in this group. It is a deep, somewhat poorly drained, nearly level silty soil on bottom land. The subsoil is slowly permeable silty clay loam and silty clay. This soil has a high water table and is subject to occasional flooding. Runoff is slow. Susceptibility to erosion and soil blowing is slight. Wetness is the main limitation to growing trees on this soil.

If drainage is adequate, this soil is well suited to windbreaks and other kinds of woody plantings. Adapted trees and shrubs grow well because of the abundant supply of moisture, but some trees do not grow well because of the high water table. Tree planting can be delayed in some years by wetness. Providing drainage helps to regulate wetness and to improve growing conditions for trees.

WINDBREAK GROUP 3

This group consists of deep, nearly level to rolling loamy soils in uplands. These soils are well drained except for one soil that is moderately well drained to somewhat poorly drained. Most of the soils in this group have high available water capacity. Permeability is moderate in the subsoil and in most of the soils is moderate or moderately slow in the underlying material. Runoff is slow to medium. The hazard of erosion is slight to severe, depending on the shape and gradient of soil slopes. Soil blowing is a slight to moderate hazard. Periodic moisture shortage caused by the climate of the area is the main limitation to tree planting.

The soils of this group are well suited to windbreaks and other types of woody plantings. Except for trees and shrubs that have high moisture requirements, all climatically adapted trees and shrub species have the potential to grow well (fig. 14).

WINDBREAK GROUP 4

This group consists of deep, moderately well drained to well drained, nearly level to gently sloping soils that have compact subsoils of clay loam or silty clay. These soils have moderate or high available water capacity, but permeability is slow or moderately slow in the subsoil. Some of the soils contain salts in the lower part of the subsoil or in the underlying material. Runoff is slow to medium. Susceptibility to erosion and soil blowing is slight to moderate. The clayey subsoil is somewhat restrictive to the development of plant roots.

The soils in this group are moderately well suited to windbreaks and other types of woody plantings. Most

TABLE 3.—*Height of trees and shrubs at 20 years of age, by windbreak suitability groups*

[Some heights given are measurements and others are estimates. Absence of entry indicates that the species normally is not suitable for the specified group. Soils in windbreak group 10 are not suitable for windbreaks]

Species	Windbreak suitability group						
	1	2	3	4	5	6	9
	Ft	*Ft*	*Ft*	*Ft*	*Ft*	*Ft*	*Ft*
Northwest poplar	40–45	40–45					
Plains cottonwood	35–40	32–36					
Siouxland cottonwood	35–40	32–36					
Chinkota elm	32–36		30–32	36–40	30–34	16–20	12–14
Dropmore elm	32–36		30–32	36–40	30–34	16–20	12–14
Golden willow	32–35	30–34					
Siberian elm	32–36		30–32	36–40	30–34	16–20	12–14
White willow	32–35	30–34					
Black Hills spruce	24–30	20–24	24–28				
Blue spruce	24–30	20–24	24–28				
Green ash	23–27	20–24	20–24	21–26	22–26	12–14	10–12
Hackberry	23–27	22–26	20–24	22–24	21–25	10–12	
Ponderosa pine	24–30	20–22	22–26	17–23	20–24	13–15	10–12
Scotch pine	24–30	20–22	22–26				
Boxelder	20–22	18–20	20–22				
Bur oak	20–23	18–20	18–20		18–20		
Manchurian crabapple	18–20	16–18	15–17	13–15	17–19	12–14	
Russian-olive	16–20	14–16	15–18	16–22	14–18	9–12	8–10
Siberian crabapple	18–20	16–18	15–17	13–15	17–19	12–14	
Common chokecherry	12–14	9–11	9–12	10–12	9–11		
Eastern redcedar	15–18	14–16	13–15	15–17	13–15	9–12	6–8
Harbin pear	16–18	14–16	15–17	13–15	15–17	11–12	5–7
Rocky Mountain juniper	15–18	14–16	13–15	15–17	13–15	9–12	6–8
Siberian apricot	12–14		12–15	10–14	11–13		
American plum	8–9	5–6	8–9	8–9	6–7		
Amur maple	10–12	10–11	9–10				
Siberian peashrub	9–11	7–9	9–10	7–8	8–10	6–7	5–6
Silver buffaloberry	8–10	6–8	7–9	7–9	6–8	5–6	3–4
Tatarian honeysuckle	8–10	6–8	7–9	8–10	6–7	5–7	
Late lilac	8–9	6–7	6–7				
Lilac	7–8	5–6	6–7	4–5	6–7	4–5	3–4
Nanking cherry[1]	5–7	6–8	5–6	4–5	6–8		
Peking cotoneaster	6–7	5–6	5–6	6–7	6–7	4–5	
Redosier dogwood	6–7	6–7	5–7				
Golden currant	4–5	4–5	4–5	3–5	3–5		
Saskatoon serviceberry	5–6	5–6					
Skunkbush sumac	3–7	5–6	5–6		4–5		
Western sandcherry[2]	3–4		3–4		4–5		

[1] Vigor generally declines in 10 years or less.

[2] Vigor generally declines in 5 years or less.

of the climatically adapted trees and shrubs have the potential to grow well (fig. 15).

WINDBREAK GROUP 5

This group consists of deep, well drained to somewhat poorly drained, nearly level to gently undulating loamy soils in uplands. These soils have a surface layer of fine sandy loam and sandy loam, and a subsoil of sandy loam. Available water capacity is low or moderate. Permeability is moderately rapid except in one of the soils, where it is slow in the subsoil. Runoff is slow. There is a severe hazard of soil blowing.

The soils in this group are well suited to windbreaks and other types of woody plantings. Except for those species that have high moisture requirements, most of the climatically adapted trees and shrubs have the potential to grow well. A cover crop or a mulch of crop residue helps control soil blowing until the windbreak is established.

WINDBREAK GROUP 6

This group consists of well-drained, nearly level to undulating loamy soils that are moderately deep to sand and gravel or to sand. These soils have low or moderate available water capacity and are droughty for trees and shrubs. Permeability is moderate in the subsoil and is rapid in the underlying material. Runoff is slow to medium. Susceptibility to erosion and soil blowing is slight to moderate.

The soils in this group are poorly suited to windbreaks and other kinds of woody plantings. Field windbreaks are not feasible. If suitable trees and shrubs are selected, it is possible to establish farmstead windbreaks and other kinds of woody plantings, but the

Figure 14.—**A 2-year-old field windbreak on Williams-Bowbells loams, 3 to 6 percent slopes. Good site preparation and clean cultivation has resulted in an excellent stand of trees and shrubs.**

potential for survival, growth, and vigor is less than optimum.

WINDBREAK GROUP 9

The Noonan part of Niobell-Noonan loams, 1 to 5 percent slopes, is the only soil in this group. It is a deep, moderately well drained soil that has a claypan subsoil. Available water capacity is high, but the claypan subsoil has slow permeability and releases moisture slowly to plants. Salts commonly are in the lower part of the subsoil or in the underlying material. Runoff is slow to medium. Susceptibility to erosion and soil blowing is slight to moderate.

This soil is poorly suited to windbreaks and other types of woody plantings. Field windbreaks are not feasible. If suited trees and shrubs are selected, it is possible to establish farmstead windbreaks and other kinds of woody plantings, but survival, growth, and vigor are less than optimum.

WINDBREAK GROUP 10

The soils in this group range widely in characteristics and properties that affect their suitability for windbreak plantings. Some are too stony, too steep, or too wet for the use of tree planting machinery. Some are too poorly drained or too droughty for the survival of trees and shrubs. Some are strongly alkaline or contain enough salts to inhibit the growth of trees and shrubs.

These soils are unsuited to windbreak plantings normally planted with machinery. Scalp plantings for wildlife, recreation, or beautification are possible on most of the soils in this group. Such plantings require special care if they are to survive. It is important to select those species of trees and shrubs best adapted to the limitations of the site.

Wildlife[7]

Wildlife, a product of the land, responds to good soil management. The level of wildlife production depends on the presence of essential habitat of food and cover. The nature and adequacy of habitat plants, both introduced and native, are closely associated with the suitability of the soil for growing these plants. Wildlife differs from other products of the land in that it is dependent on many kinds of soil to produce the many habitat needs required by each individual species of wildlife. Because of this, interpretation of soils for wildlife potential can best be related to soil associations.

The suitability of the seven soil associations in Edmunds County to produce wildlife habitat appropriate to particular kinds of wildlife is shown in table 4. The suitability of the major soils in each association are rated for the different kinds of wildlife. The kinds of wildlife are described in the following paragraphs.

[7] By JOHN B. FARLEY, biologist, Soil Conservation Service.

Figure 15.—**Farmstead windbreak on Mondamin silty clay loam, 0 to 2 percent slopes. Such plantings also provide habitat for wildlife.**

Farmland wildlife are animals that frequent cropland, pastures, meadows, and planted woodland. Although these animals use other areas, such as natural woodland and heavily vegetated marshland, they are most closely associated with the cultured areas. Examples of this kind of wildlife are pheasant, gray partridge, bobwhite, mourning dove, cottontail, jackrabbit, fox, raccoon and white-tail deer.

Woodland wildlife are animals that occur on sizable areas of naturally wooded land. These areas are bordered by and frequently include farmland, range, and pasture. The occurrence of sizeable areas of natural woodland is, however, the habitat element affecting wildlife. Planted woodland is not considered in this rating because seedlings can be established on many more soils than they will occur on naturally. Examples of this kind of wildlife are mule deer, white-tail deer, cottontail, tree squirrels, raccoon, coyote, turkey, ruffed grouse, thrushes, vireos, and scarlet tanager.

Wetland wildlife are animals that use natural wetland or improved natural wetland for all or part of their need for breeding habitat (fig. 16). Examples of this kind of wildlife are ducks, herons, shorebirds, coot, red-winged blackbird, mink, muskrat, and beaver.

Rangeland wildlife include animals that occur on extensive areas maintained in native plant communities, normally referred to as range. Extensive areas of range frequently include wooded draws, wooded alluvial land, farm areas, and some planted woodland. Range, however, is the major habitat element affecting wildlife. Examples of this kind of wildlife are mule deer, white-tail deer, antelope, jackrabbit, coyote, sharp-tailed grouse, sage grouse, prairie chicken, magpie, horned lark, lark bunting, and mourning dove.

The ratings in table 4 are described as good, fair, poor, and very poor. A rating of *good* means habitat can be easily established, constructed, improved, or maintained. There are few or no soil limitations in habitat management, and satisfactory results are generally assured. A rating of *fair* means habitat usually can be created, constructed, improved, or maintained on these soils, but there are moderate soil limitations that affect habitat management or construction. A moderate intensity of management and fairly frequent attention may be required to assure satisfactory results. A rating of *poor* means habitat can frequently be created, improved, or maintained, but there are rather severe soil limitations. Habitat establishment or management can be difficult, expensive, or require intensive effort. Results are doubtful. A rating of *very poor*

means naturally occurring habitats can sometimes be maintained with specific management, but it is generally not possible or feasible to establish, construct, or improve habitat on these soils.

Engineering [8]

This section is useful to those who need information about soils used 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.

Among the properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, 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 kinds of soil on which they are built, for the purpose of predicting 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 5, 6, 7, and 8, which show estimated physical and chemical properties, engineering interpretations for various engineering uses, and results of engineering laboratory tests on soil samples.

This information, along with the soil map and other parts of this survey, can be used to make interpretations in addition to those given in tables 5 and 6, and it also can be used to make other useful maps.

This information, however, does not eliminate 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

[8] GORDON W. STROUP, assistant State conservation engineer, Soil Conservation Service, helped prepare this section.

Figure 16.—A duck and her brood in area of Marsh.

TABLE 4.—*Wildlife habitat, by soil associations*

Soil association	Percentage of association	Suitability of—			
		Farmland	Woodland	Wetland	Rangeland
1. Niobell-Noonan:					
Niobell	25	Fair	Very poor	Very poor	Good.
Noonan	20	Poor	Poor	Very poor	Poor.
Williams	(1)	Good	Very poor	Very poor	Good.
Heil	(1)	Very poor	Very poor	Poor	Poor.
2. Bryant:					
Bryant	55	Good	Very poor	Very poor	Good.
Grassna	(1)	Good	Very poor	Very poor	Good.
3. Williams-Bowbells:					
Williams	40	Good	Very poor	Very poor	Good.
Bowbells	20	Good	Poor	Poor	Fair.
Nishon	(1)	Poor	Poor	Good	Fair.
4. Williams-Vida:					
Williams	40	Good	Very poor	Very poor	Good.
Vida	20	Very poor	Very poor	Very poor	Fair.
Bowbells	(1)	Good	Poor	Poor	Fair.
Parnell	(1)	Very poor	Poor	Good	Fair.
5. Bryant-Mondamin:					
Bryant	40	Good	Very poor	Very poor	Good.
Mondamin	20	Good	Very poor	Very poor	Good.
Williams	(1)	Good	Very poor	Very poor	Good.
Parnell	(1)	Very poor	Poor	Good	Fair.
6. Temvik-Williams:					
Temvik	25	Good	Very poor	Very poor	Good.
Williams	20	Good	Very poor	Very poor	Good.
7. Lehr-Bowdle:					
Lehr	40	Poor	Very poor	Very poor	Good.
Bowdle	30	Fair	Very poor	Very poor	Good.
Bryant	(1)	Good	Very poor	Very poor	Good.

[1] Percentages not given for minor soils in the associations.

than 6 feet. Also, inspection of sites, especially the small ones, is needed because many mapped areas of a given soil may contain small areas of other kinds of soils that have strongly contrasting properties and different suitabilities or limitations for engineering.

Some of the terms used in this soil survey have special meanings in soil science that may not be familiar to engineers. The Glossary defines many 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 system (*10*) used by Soil Conservation Service engineer, the Department of Defense, and others and the AASHTO system (*1*) adopted by the American Association of State Highway and Transportation Officials.

In the Unified system soils are classified according to particle-size distribution, plasticity, liquid limit, and organic matter. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes, for example, CL–ML.

The AASHTO system is used in classifying soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic 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, or 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 mineral 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 tables 7 and 8; the estimated classification, without group index numbers, is given in table 5 for all soils mapped in the survey area.

Estimated properties significant in engineering

Estimated physical and chemical soil properties significant in engineering are listed in table 5. Evaluations are made for the representative soil of each soil series by layers sufficiently different from each other to each have unique significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for specified and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in table 5.

Depth to bedrock is the distance from the surface of the soil to a rock layer within the depth of observation.

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

Soil texture is described in table 5 in the standard terms used by the Department of Agriculture. These terms take into account relative percentages of sand, silt, and clay in soil material 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, as for example, "gravelly loamy sand." "Sand, "silt," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary of this survey.

Liquid limit and plasticity index pertain to the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from the plastic to the liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index in table 5 are estimated; in tables 7 and 8 the data on liquid limit and plasticity index are based on tests of soil samples.

Permeability is the quality that enables a soil to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly structure and texture. The estimates in table 5 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

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

Reaction is the degree of acidity or alkalinity of a soil, expressed in pH values. The pH value and terms used to describe soil reaction are explained in the Glossary.

Salinity refers to the amount of soluble salts in the soil. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25° C. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its corrosiveness to metals and concrete. Terms for soil salinity classes and their numerical ratings are explained in the Glossary.

Shrink-swell potential is the relative change in volume to be expected of soil material with changes in moisture content, that is, the extent which the soil shrinks as it dries out or swells when it is wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling causes much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

Risk of corrosion in table 5 pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. Rate of corrosion of uncoated steel is related to soil properties such as drainage, texture, total acidity, and electrical conductivity of the soil. Corrosivity for concrete is influenced mainly by the content of sodium or magnesium sulphate but also by soil texture and acidity. Installations of uncoated steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely in one kind of soil or in one soil horizon. A rating of *low* indicates a low probability of self-induced corrosion. A rating of *high* indicates a high probability of damage; protective measures for steel and more resistant concrete are needed to avoid or minimize damage.

Engineering interpretations

The estimated interpretations in table 6 are based on the engineering properties of soils shown in table 5, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Edmunds County. In table 6, ratings are used to summarize limitation or suitability of the soils for all listed purposes other than for drainage of cropland and pasture, irrigation, pond reservoirs, embankments, and terraces and diversions. For those uses, table 6 lists those soil features that need to be considered in planning, installation, and maintenance.

Soil limitations are indicated by the ratings *slight, moderate,* and *severe. Slight* means that soil properties are generally favorable for the rated use, or in other words, limitations are minor and are easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* indicates soil properties so unfavorable and so difficult to correct or overcome that major soil reclamation, special design, or intensive maintenance is required.

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

Following are explanations of some of the columns in table 6.

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 both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility

TABLE 5.—*Estimated physical*

[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. The instructions for referring to other series that appear in the first column

Soil series and map symbols	Depth to—		Depth from surface	Dominant USDA texture	Classification	
	Bedrock	Seasonal high water table			Unified	AASHTO
	Ft	*Ft*	*In*			
Bearden: Ba	>5	3–5	0–12	Loam	CL-ML or CL	A–6 or A–4
			12–40	Silt loam	CL-ML or CL	A–6 or A–4
			40–60	Silty clay loam	CL	A–6 or A–7
*Bowbells: Bc	>5	>5	0–6	Loam	CL-ML or CL	A–6 or A–4
For Cresbard part of Bc, see Cresbard series.			6–26	Clay loam	CL	A–6 or A–7
			26–60	Clay loam	CL	A–6 or A–7
Bowdle: BoA, BoB	>5	>5	0–8	Loam	CL-ML or CL	A–6 or A–4
			8–22	Loam	CL-ML or CL	A–6 or A–4
			22–60	Sand and gravel	SC, SM, SW–SM, GM or GC	A–1 or A–2
*Bryant: BrA, BrB, BrC, BxB	>5	>5	0–8	Loam	CL-ML or CL	A–6 or A–4
For Grassna part of BxB, see Grassna series.			8–15	Clay loam	ML or CL	A–6 or A–4
			15–60	Loam	CL	A–6 or A–4
Bryant, sandy substratum: BvA.	>5	>5	0–14	Loam	CL-ML or CL	A–6 or A–4
			14–27	Loam	ML or CL	A–6 or A–4
			27–60	Sand	SM or SC	A–2
Cresbard	>5	>5	0–10	Loam	CL	A–6
Mapped only with Bowbells soils.			10–32	Clay loam	CL or CH	A–7
			32–60	Loam	CL	A–6 or A–7
Divide: Dv	>5	3–5	0–14	Loam	CL-ML or CL	A–4 or A–6
			14–34	Loam	CL-ML or CL	A–4 or A–6
			34–60	Sand and gravel	SC, SM, GM, GC, or SW–SM	A–1 or A–2
Edgeley: EdE	>5	>5	0–10	Loam	CL	A–6
			10–20	Clay loam	CL	A–6
			20–34	Shaly clay loam	CL	A–6 or A–7
			34–60	Shale.		
Grassna: Gr	>5	>5	0–25	Loam	ML, CL-ML or CL	A–6 or A–4
			25–60	Loam	CL or ML	A–6 or A–4
Harriet	>5	<4	0–4	Silt loam	CL-ML or CL	A–6 or A–7
Mapped only with Ranslo soils.			4–20	Silty clay	CH or MH	A–7
			20–60	Clay loam	CL or CH	A–6 or A–7
Heil: He	>5	>5	0–2	Silt loam	CL	A–6 or A–7
			2–25	Clay	CH	A–7
			25–60	Clay loam	CL or CH	A–6 or A–7
*Lehr: LeA, LeB, LhB	>5	>5	0–16	Loam	CL-ML or CL	A–6 or A–4
For Bowdle part of LhB, see Bowdle series.			16–60	Sand and gravel	SC, SM, GC, GM, or SW–SM	A–1 or A–2
Letcher: Lt	>5	4–6	0–15	Fine sandy loam	ML or SM	A–2 or A–4
			15–32	Sandy loam	SM or ML	A–2 or A–4
			32–48	Loam	CL-ML or CL	A–6 or A–4
			48–60	Sandy loam	SM or SC	A–2 or A–4
Loamy Fluvaquents: Lv	>5	2–5	0–60	Loam	CL or CL–ML	A–4 or A–6
Marsh: Mb. Too variable to be rated.						

and chemical properties

soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the of this table. Symbol > means more than; symbol < means less than]

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Risk of corrosion	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)								Uncoated steel	Concrete
				Pct		*In per hr*	*In per in of soil*	*pH*	*Mmhos/cm*			
100	100	85–95	60–75	15–35	5–20	0.6–2.0	0.18–0.20	7.9–8.4	<2	Low	High	Low.
100	100	90–100	70–90	25–40	5–25	0.2–0.6	0.14–0.17	7.9–8.4	2–4	Moderate	High	Low.
100	100	95–100	85–95	25–45	15–30	0.2–0.6	0.17–0.20	7.9–8.4	2–4	Moderate or high.	High	Low.
95–100	90–100	85–95	60–75	20–40	5–25	0.6–2.0	0.18–0.20	6.1–6.5	<2	Moderate	Moderate	Low.
95–100	90–100	80–95	70–80	20–50	11–30	0.6–2.0	0.19–0.22	6.6–7.8	<2	Moderate	High	Low.
95–100	90–100	80–95	70–80	20–50	11–30	0.2–0.6	0.17–0.20	7.9–8.4	<2	Moderate	High	Low.
100	95–100	85–95	60–85	15–35	5–20	0.6–2.0	0.18–0.20	6.6–7.3	<2	Low	Moderate	Low.
100	95–100	90–100	70–80	25–40	5–25	0.6–2.0	0.18–0.20	6.6–7.3	<2	Moderate	Moderate	Low.
40–80	25–75	15–70	5–30	0–25	[1] NP–10	6.0–20.0	0.03–0.06	7.4–7.8	<2	Low	Moderate	Low.
100	100	90–100	80–100	15–35	5–20	0.6–2.0	0.18–0.20	6.6–7.3	<2	Low	Moderate	Low.
100	100	90–100	85–100	25–40	5–20	0.6–2.0	0.19–0.22	6.6–7.3	<2	Moderate	High	Low.
100	100	90–100	85–100	25–40	5–20	0.6–2.0	0.17–0.20	7.4–8.4	<2	Moderate	High	Low.
100	100	90–100	80–100	15–35	5–25	0.6–2.0	0.18–0.20	6.6–7.3	<2	Low	Moderate	Low.
100	100	90–100	85–100	25–40	5–20	0.6–2.0	0.16–0.18	6.6–7.3	<2	Moderate	High	Low.
100	100	65–85	20–35	0–20	NP–10	6.0–20.0	0.06–0.08	7.9–8.4	<2	Low	Low	Low.
95–100	90–100	85–95	60–75	20–40	10–20	0.6–2.0	0.18–0.20	5.6–6.0	<2	Moderate	Low	Low.
95–100	90–100	85–95	70–90	40–60	15–40	0.06–0.6	0.13–0.16	6.1–7.8	<2	High	High	Moderate.
95–100	90–100	80–100	75–95	25–50	15–30	0.6–2.0	0.13–0.15	7.9–9.0	2–8	High	High	Moderate.
100	100	85–95	60–75	15–35	5–20	0.6–2.0	0.18–0.20	7.4–8.4	<2	Low	Moderate	Low.
90–100	90–100	85–95	55–75	20–40	5–25	0.6–2.0	0.13–0.15	7.9–9.0	<2	Low	High	Low.
25–75	15–65	10–40	5–25	0–25	NP–15	6.0–20.0	0.03–0.06	7.9–8.4	<2	Low	High	Low.
95–100	90–100	85–95	60–80	20–40	10–25	0.6–2.0	0.18–0.20	6.1–6.5	<2	Low	Low	Low.
95–100	90–100	85–95	70–80	25–40	10–35	0.6–2.0	0.17–0.20	7.4–7.8	<2	Moderate	Moderate	Low.
95–100	90–100	85–95	70–80	30–50	15–35	0.06–0.2	0.14–0.17	7.9–8.4	<2	Moderate	High	Moderate.
100	100	90–100	80–100	20–40	5–20	0.6–2.0	0.18–0.20	6.6–7.8	<2	Moderate	High	Low.
100	100	90–100	65–95	20–45	5–25	0.6–2.0	0.17–0.20	7.4–8.4	<2	Moderate	High	Low.
100	100	90–100	85–95	15–45	5–20	0.6–2.0	0.19–0.22	6.6–7.3	<2	Moderate	High	Moderate.
100	100	95–100	85–95	50–90	10–55	0.06–0.2	0.10–0.15	7.4–9.0	4–8	High	High	Moderate.
100	90–100	85–95	70–80	25–55	10–35	0.2–0.6	0.11–0.14	8.5–9.0	4–16	Moderate	High	Moderate.
100	100	90–100	85–100	20–40	10–30	0.6–2.0	0.19–0.22	6.6–7.3	<2	Moderate	High	Low.
100	100	90–100	85–100	50–70	25–45	<0.06	0.07–0.11	6.6–8.4	<2	High	High	High.
100	90–100	85–100	75–100	40–60	15–35	0.2–0.6	0.11–0.14	7.9–9.0	4–12	High	High	High.
100	95–100	85–95	60–75	15–35	5–20	2.0–6.0	0.18–0.20	6.6–7.8	<2	Low	Moderate	Low.
40–80	25–75	15–70	5–30	0–25	NP–10	6.0–20.0	0.03–0.06	7.4–7.8	<2	Low	Moderate	Low.
100	100	60–85	30–55	10–30	NP–5	0.6–2.0	0.11–0.17	5.1–6.5	<2	Low	Low	Low.
100	100	60–75	30–55	10–35	NP–10	0.06–0.2	0.08–0.12	6.6–8.4	<2	Low	High	Moderate.
100	100	60–95	50–75	15–35	5–15	0.06–0.2	0.15–0.18	7.9–8.4	2–4	Moderate	High	Moderate.
100	100	60–70	30–40	10–25	NP–10	2.0–6.0	0.06–0.10	8.5–9.0	2–8	Low	High	Moderate.
100	90–100	80–95	60–75	25–40	5–25	0.6–2.0	0.18–0.20	6.6–8.4	0–4	Moderate	High	Moderate.

TABLE 5.—*Estimated physical*

Soil series and map symbols	Depth to—		Depth from surface	Dominant USDA texture	Classification	
	Bedrock	Seasonal high water table			Unified	AASHTO
	Ft	*Ft*	*In*			
Miranda Mapped only with Niobell soils.	>5	>5	0–4 4–10 10–60	Loam Clay loam Clay loam	CL-ML or CL CL or CH CL	A–4 or A–6 A–6 or A–7 A–6 or A–7
*Mondamin: MdA, MdB, Mh For Heil part of Mh, see Heil series.	>5	>5	0–6 6–13 13–60	Silty clay loam Silty clay Silty clay loam	CL CH or CL CL	A–6 or A–7 A–7 A–6 or A–7
*Niobell: NmA, NpB For Miranda part of NmA, see Miranda series; for Noonan part of NpB, see Noonan series.	>5	>5	0–6 6–16 16–26 26–60	Loam Clay loam Clay loam Clay loam	CL-ML or CL CL CL CL	A–4 or A–6 A–6 A–6 or A–7 A–6 or A–7
Nishon Mapped only with Tonka and Williams soils.	>5	>5	0–10 10–22 22–60	Silt loam Clay Clay loam	CL-ML or CL CH or MH CL or CH	A–6 or A–4 A–7 A–6 or A–7
Noonan Mapped only with Niobell soils.	>5	>5	0–10 10–22 22–60	Loam Clay loam Clay loam	CL-ML or CL CL or CH CL	A–4 or A–6 A–6 or A–7 A–6 or A–7
Parnell: Pa	>5	0–6	0–6 6–32 32–60	Silty clay loam Silty clay Silty clay loam	CL or CH CH or MH CL or CH	A–6 or A–7 A–7 A–7
*Ranslo: Rh For Harriet part of Rh, see Harriet series.	>5	<4	0–9 9–26 26–35 35–60	Silt loam Silty clay loam Silty clay Clay loam	CL-ML or CL CH or CL CH CL or CH	A–4 or A–6 A–7 A–7 A–6 or A–7
Regan: Rn	>5	0–2	0–5 5–24 24–44 44–60	Silt loam Silt loam Silt loam Sand and gravel	CL-ML or CL CL CL SC, SM, GC, GM, or SW–SM	A–4 or A–6 A–6 or A–7 A–6 or A–7 A–1 or A–2
Spottswood: Sp	>5	3–6	0–20 20–30 30–60	Loam Loam Sand and gravel	CL-ML or CL CL SC, SM, GC, GM, or SW–SM	A–4, A–6, or A–7 A–6 A–1 or A–2
Tally: TaB	>5	>5	0–8 8–16 16–29 29–60	Fine sandy loam Sandy loam Sandy loam Loamy fine sand	SM or SC SM or SC SM or SC SM or SM–SC	A–4 A–4 or A–2 A–4 or A–2 A–2
*Temvik: TbB, TgB, TgC For Bryant part of TbB, see Bryant series; for Grassna part of TgB and TgC, see Grassna series.	>5	>5	0–14 14–37 37–60	Loam Loam Clay loam	CL-ML or CL CL CL	A–6 or A–4 A–6 A–6 or A–7
*Tonka: Tn For Nishon part of Tn, see Nishon series.	>5	>5	0–13 13–24 24–60	Silt loam Silty clay Clay loam	CL CH or MH CL	A–6 or A–7 A–7 A–6 or A–7
*Vida: VdC, VwC, VzE For Williams part of VwC, see Williams series; for Zahill part of VzE, see Zahill series.	>5	>5	0–5 5–9 9–26 26–60	Loam Clay loam Clay loam Clay loam	CL-ML or CL CL CL CL	A–4 or A–6 A–6 or A–7 A–6 or A–7 A–6 or A–7

and chemical properties—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Risk of corrosion	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)								Uncoated steel	Concrete
				Pct		*In per hr*	*In per in of soil*	*pH*	*Mmhos/cm*			
100	100	85–95	60–75	15–35	5–20	0.6–2.0	0.18–0.20	6.6–7.3	<2	Low	High	Moderate.
95–100	95–100	85–95	60–80	25–55	15–35	<0.06	0.16–0.19	7.3–8.4	2–4	Moderate	High	Moderate.
95–100	95–100	85–95	60–80	25–45	15–35	<0.06	0.14–0.17	8.5–9.0	4–8	Moderate	High	Moderate.
100	100	95–100	85–100	25–50	10–30	0.2–0.6	0.19–0.22	6.1–6.6	<2	Moderate	High	Low.
100	100	95–100	90–100	40–75	20–50	0.06–0.6	0.13–0.18	6.6–7.3	<2	High	High	Low.
100	100	95–100	85–100	25–50	10–30	0.06–0.6	0.17–0.20	7.4–8.4	<2	High	High	Low.
100	95–100	85–95	60–75	15–35	5–20	0.6–2.0	0.18–0.20	6.6–7.3	<2	Low	High	Low.
100	95–100	85–95	60–80	25–40	10–25	0.2–0.6	0.19–0.22	6.6–7.3	<2	Moderate	High	Low.
95–100	95–100	85–95	60–80	30–50	10–35	0.06–0.2	0.14–0.17	7.4–8.4	<2	High	High	Moderate.
95–100	95–100	85–95	60–80	25–45	15–35	0.2–0.6	0.14–0.17	7.9–9.0	2–8	Moderate	High	Moderate.
100	100	90–100	70–95	20–40	5–25	0.6–2.0	0.17–0.20	6.6–7.3	<2	Low	High	Low.
100	100	90–100	85–95	50–70	15–45	0.06–0.2	0.11–0.16	7.4–7.8	<2	High	High	Low.
100	90–100	85–95	75–90	30–60	15–35	0.2–0.6	0.17–0.20	7.9–8.4	<2	High	High	Low.
100	100	85–95	60–75	15–35	5–20	0.6–2.0	0.18–0.20	6.6–7.3	<2	Low	High	Low.
95–100	95–100	85–95	60–80	25–55	15–35	0.06–0.2	0.16–0.19	7.4–9.0	2–4	High	High	Low.
95–100	95–100	85–95	60–80	25–45	15–35	0.2–0.6	0.14–0.17	7.9–9.0	2–8	Moderate	High	Moderate.
100	95–100	95–100	75–95	30–55	10–35	0.06–0.2	0.16–0.19	6.1–6.5	<2	High	High	Low.
100	95–100	95–100	80–100	50–70	20–40	0.06–0.2	0.13–0.18	6.6–7.8	<2	High	High	Low.
100	95–100	90–100	85–100	40–65	15–35	0.06–0.2	0.16–0.19	7.9–8.4	<2	High	High	Low.
100	100	90–100	80–100	15–40	5–25	0.6–2.0	0.19–0.22	6.6–7.3	<2	Low	High	Moderate.
100	100	95–100	90–100	40–60	20–35	0.06–0.2	0.13–0.16	6.6–9.0	2	High	High	Moderate.
100	100	95–100	90–100	50–75	25–50	0.06–0.2	0.08–0.13	8.5–9.0	2–4	High	High	Moderate.
100	100	90–100	70–80	35–55	15–35	0.2–0.6	0.14–0.17	8.5–9.0	2–8	High	High	Moderate.
100	100	90–100	75–95	15–40	5–20	0.6–2.0	0.19–0.22	7.4–7.8	<2	Moderate	High	Low.
100	100	90–100	75–95	30–50	10–25	0.6–2.0	0.14–0.17	7.4–8.4	<2	Moderate	High	Moderate.
100	100	90–100	70–90	25–45	10–25	0.6–2.0	0.17–0.20	7.4–8.4	<2	Moderate	High	Moderate.
40–80	25–75	15–70	5–30	0–20	NP–10	6.0–20.0	0.03–0.06	7.4–7.8	<2	Low	High	Moderate.
100	95–100	75–95	50–75	25–50	5–25	0.6–2.0	0.18–0.20	6.1–7.8	<2	Low	Moderate	Low.
100	95–100	75–95	50–75	25–40	10–25	0.6–2.0	0.16–0.18	7.4–8.4	<2	Low	High	Low.
40–80	25–75	15–70	5–30	0–20	NP–10	6.0–20.0	0.03–0.06	7.4–8.4	<2	Low	High	Low.
100	90–100	70–85	40–50	15–35	2–10	2.0–6.0	0.14–0.17	6.1–6.5	<2	Low	Low	Low.
100	90–100	60–85	30–50	10–30	2–10	2.0–6.0	0.11–0.15	6.6–7.3	<2	Low	Moderate	Low.
100	90–100	60–85	30–50	10–30	2–10	2.0–6.0	0.09–0.13	7.4–7.8	<2	Low	Moderate	Low.
100	75–100	50–75	15–35	5–20	NP–5	2.0–6.0	0.08–0.10	7.4–7.8	<2	Low	Moderate	Low.
100	100	90–100	80–100	15–40	5–25	0.6–2.0	0.18–0.20	6.1–7.3	<2	Low	Moderate	Low.
100	100	90–100	85–100	25–40	10–30	0.6–2.0	0.16–0.18	6.6–8.4	<2	Moderate	High	Low.
95–100	90–100	80–95	70–80	30–50	15–35	0.2–0.6	0.17–0.20	7.4–8.4	0–4	Moderate	High	Low.
100	100	90–100	70–95	20–50	10–25	0.6–2.0	0.19–0.22	6.6–7.3	<2	Low or moderate.	High	Low.
100	100	90–100	85–95	50–70	10–45	0.06–0.2	0.13–0.18	6.6–7.8	<2	High	High	Low.
100	90–100	85–95	75–90	25–50	10–35	0.2–0.6	0.17–0.20	7.9–8.4	<2	High	High	Low.
100	95–100	85–95	60–75	20–40	5–20	0.6–2.0	0.18–0.20	6.6–7.3	<2	Low	Low	Low.
100	95–100	85–95	70–90	25–45	10–25	0.6–2.0	0.19–0.22	7.4–7.8	<2	Moderate	High	Low.
100	95–100	85–95	70–90	25–45	10–25	0.6–2.0	0.17–0.20	7.9–8.4	<2	Moderate	High	Low.
100	95–100	85–95	70–90	30–50	15–30	0.2–0.6	0.17–0.20	7.9–8.4	0–4	Moderate	High	Low.

TABLE 5.—*Estimated physical*

Soil series and map symbols	Depth to—		Depth from surface	Dominant USDA texture	Classification	
	Bedrock	Seasonal high water table			Unified	AASHTO
	Ft	*Ft*	*In*			
*Wabek: WaD, WbC For Bowdle part of WbC, see Bowdle series.	>5	>5	0–4 4–7 7–60	Loam Gravelly sandy loam Sand and gravel	ML or CL SM or SC SC, SM, GC, GM, or SW–SM	A–6 or A–4 A–2 or A–4 A–1 or A–2
*Williams: WnB, WnC, WtA, WtB, WvC. For Bowbells part of these units, see Bowbells series; for Nishon part of WtB, see Nishon series; for Parnell part of WvC, see Parnell series.	>5	>5	0–4 4–10 10–24 24–60	Loam Clay loam Clay loam Clay loam	CL-ML or CL CL CL CL	A–6 or A–4 A–6 or A–7 A–6 or A–7 A–6 or A–7
Zahill Mapped only with Vida soils.	>5	>5	0–4 4–18 18–60	Loam Clay loam Clay loam	CL-ML or CL CL-ML or CL CL	A–6 or A–4 A–6 or A–7 A–6 or A–7

[1] Nonplastic.

to flooding. Slope is a soil property that affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large stones 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 assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Those that affect the pond floor are permeability, organic matter, and slope; and if the floor needs to be leveled, depth to bedrock becomes important. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified Soil Classification and the amounts of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet, as 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 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 capacity to support load and resist settlement under load, and those that relate to ease of excavation. Soil properties that affect 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 a method of disposing of refuse 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 6 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 that. 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 have an all weather surface expected to carry automobile traffic all year. 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 classifications of the soil material, and also

and chemical properties—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Risk of corrosion	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)								Uncoated steel	Concrete
				Pct		*In per hr*	*In per in of soil*	*pH*	*Mmhos/cm*			
100	95–100	85–95	60–75	15–35	5–20	0.6–2.0	0.18–0.20	6.6–7.3	<2	Low	Moderate	Low.
60–85	50–70	30–50	25–40	5–20	NP–10	2.0–6.0	0.09–0.13	7.4–7.8	<2	Low	Moderate	Low.
40–80	25–75	15–70	5–30	0–20	NP–10	6.0–20.0	0.03–0.06	7.4–7.8	<2	Low	Low	Low.
100	95–100	85–95	60–75	20–40	5–20	0.6–2.0	0.18–0.20	6.6–7.3	<2	Low	Low	Low.
100	90–100	85–95	70–90	25–50	10–30	0.6–2.0	0.19–0.22	6.6–7.3	<2	Moderate	High	Low.
100	90–100	85–95	70–90	25–50	10–30	0.6–2.0	0.17–0.20	6.6–7.8	<2	Moderate	High	Low.
100	95–100	85–95	70–90	25–50	10–30	0.2–0.6	0.17–0.20	7.4–8.4	0–4	Moderate	High	Low.
100	95–100	85–95	60–90	20–40	5–20	0.6–2.0	0.18–0.20	7.4–7.8	<2	Low	Low	Low.
100	90–100	85–95	70–90	30–45	10–25	0.6–2.0	0.17–0.20	7.9–8.4	<2	Moderate	Moderate	Low.
100	95–100	85–95	70–90	25–45	10–30	0.2–0.6	0.17–0.20	7.9–8.4	0–4	Moderate	High	Low.

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 the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and the relative ease of excavating the material at borrow areas.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 6 provide guidance about where to look for probable sources. A soil rated as a *good* or *fair* source of sand or gravel 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 mining of the materials, and neither do they indicate quality of the deposit.

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

Embankments, dikes, and levees require soil material resistant to seepage and piping and of 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 for crops and pasture is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope, stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation of a soil is affected by such features as slope; susceptibility to stream overflow, water erosion or soil blowing; soil 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 in claypans or 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.

Terraces and diversions are embankments or ridges constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock or other unfavorable material; presence of stones; permeability; and resistance to water erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

Grassed waterways are affected by those features and qualities of soils that affect the establishment,

TABLE 6.—*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. The instructions for referring to other series

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill	Local roads and streets
Bearden: Ba	Severe: moderately slow permeability; seasonal high water table.	Moderate: seasonal high water table at 3 to 5 feet.	Severe: seasonal water table; somewhat poorly drained.	Severe: somewhat poorly drained.	Severe: seasonal high water table.	Severe: high potential frost action.
*Bowbells: Bc For Cresbard part of Bc, see Cresbard series.	Severe: moderately slow permeability in substratum.	Slight	Moderate: moderately well drained.	Moderate: moderately well drained; moderate shrink-swell potential. Severe if not protected from flooding.	Severe: water accumulates from adjacent slopes.	Severe: AASHTO group index more than 8; CL material with PI more than 15.
Bowdle: BoA, BoB	Slight[1]	Severe: rapid permeability in substratum.	Severe: sand and gravel below 20 inches.	Slight	Severe: rapid permeability in substratum.	Slight
*Bryant: BrA, BrB, BrC, BxB For Grassna part of BxB, see Grassna series.	Moderate: moderate permeability.	Moderate if slope is less than 6 percent; moderate permeability. Severe if slope is more than 6 percent.	Slight	Moderate: moderate shrink-swell potential.	Slight	Moderate or severe: ML or CL material with PI of 5 to 20.
Bryant, sandy substratum: BvA.	Slight[1]	Severe: rapid permeability in substratum.	Severe: sand below 20 inches; sloughing hazard.	Slight	Severe: rapid permeability in substratum.	Moderate or severe in material above sand and gravel; PI of 5 to 20.
Cresbard Mapped only with Bowbells soils.	Severe: moderately slow or slow permeability.	Slight	Moderate: moderately well drained.	Severe: moderately well drained; high shrink-swell potential.	Moderate if protected from runoff; clay loam subsoil.	Severe: high shrink-swell potential; AASHTO group index more than 8.

interpretations

soil in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the that appear in the first column of this table]

Suitability as source of—			Soil features affecting—					
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Fair or poor: moderate or high shrink-swell potential.	Unsuited	Fair: surface less than 16 inches thick.	Moderately slow permeability in substratum; seasonal high water table.	Medium or low shear strength; medium compressibility; low permeability of compacted soil.	Moderately slow permeability; seasonal high water table.	High available water capacity; moderate water intake; seasonal high water table.	Slopes less than 2 percent; moderate soil blowing hazard.	All features favorable.
Poor: CL material with PI more than 15.	Unsuited	Good	Moderately slow permeability in substratum.	Medium or low shear strength; medium compressibility; low permeability of compacted soil.	Moderately slow permeability; concave swales that receive water from adjacent slopes.	High available water capacity; moderate water intake.	Concave swales; slopes generally less than 2 percent.	All features favorable.
Good	Fair to poor below 20 inches depending on fines.	Good	Rapid permeability in substratum; high seepage.	Medium or high shear strength; low to medium compressibility; medium to low permeability of compacted soil.	Rapid permeability in substratum.	Low or moderate available water capacity; moderately deep rooting zone.	Rapid permeability below 20 inches; sand and gravel substratum limits channel cuts.	Erosion hazard on more than 2 percent slopes; sand and gravel at 20 to 40 inches.
Fair or poor: ML or CL material with PI of 5 to 20.	Unsuited	Good	Moderate permeability.	Medium or low shear strength; medium compressibility; fair or poor compaction.	Well drained	Moderately slow water intake rate; high available water capacity.	Long smooth slopes; moderate permeability.	Well drained; erosion hazard on sloping areas.
Fair or poor in material above sand and gravel; PI of 5 to 20.	Fair to poor below 20 inches depending on fines.	Good	Rapid permeability in substratum; high seepage.	Medium or low shear strength; low or medium compressibility; medium or low permeability of compacted soil.	Well drained	Low or moderate available water capacity; deep rooting zone.	Sand substratum at 20 to 40 inches.	Sand substratum at 20 to 40 inches.
Poor: high shrink-swell potential; AASHTO group index more than 8.	Unsuited	Fair: surface less than 16 inches thick.	Moderately slow or slow permeability.	Medium or low shear strength; medium compressibility; low permeability of compacted soil.	Moderately slow or slow permeability; concave swales that receive water from adjacent slopes.	Slow intake rate; subject to salt accumulation in substratum.	Concave swales; slopes generally less than 2 percent.	Moderately slow or slow permeability.

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill	Local roads and streets
Divide: Dv	Severe: seasonal high water table.	Severe: rapid permeability in substratum.	Severe: moderately well drained or somewhat poorly drained; sand and gravel at 20 to 40 inches.	Moderate or severe: moderately well drained or somewhat poorly drained.	Severe: seasonal high water table; rapid permeability in substratum.	Moderate: moderately well drained or somewhat poorly drained; moderate potential frost action.
Edgeley: EdE	Severe: less than 40 inches to shale.	Severe: slopes more than 6 percent.	Moderate: clay loam subsoil; rippable shale at 20 to 40 inches.	Moderate: moderate shrink-swell potential; rippable shale at 20 to 40 inches.	Moderate: rippable shale at 20 to 40 inches.	Moderate: moderate shrink-swell potential.
Grassna: Gr	Moderate: moderate permeability.	Moderate: moderate permeability.	Moderate: moderately well drained; slight if protected from runoff water.	Moderate: moderately well drained; moderate shrink-swell potential.	Moderate: water accumulates from adjacent slopes; slight if protected from runoff water.	Moderate: moderate shrink-swell potential; moderate potential frost action.
Harriet Mapped only with Ranslo soils.	Severe: seasonal high water table; slow permeability.	Slight	Severe: water table; subject to flooding.	Severe: water table less than 4 feet; subject to flooding.	Severe: subject to flooding; water table.	Severe: poorly drained; water table; subject to flooding; high potential frost action.
Heil: He	Severe: frequent ponding; very slow permeability.	Severe: frequent ponding; slight if water is not likely to enter or damage lagoon.	Severe: poorly drained; frequent ponding; clay subsoil.	Severe: high shrink-swell potential; frequent ponding.	Severe: frequent ponding; poorly drained; clay subsoil.	Severe: poorly drained; frequent ponding; AASHTO group index more than 8.
*Lehr: LeA, LeB, LhB For Bowdle part of LhB, see Bowdle series.	Slight[1]	Severe: rapid permeability in substratum.	Severe: shallow to sand and gravel.	Slight	Severe: rapid permeability in substratum.	Slight

interpretations—Continued

Suitability as source of—			Soil features affecting—					
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Fair: moderately well or somewhat poorly drained; moderate potential frost action.	Fair or poor below 20 inches depending on fines.	Good	Seasonal water table; rapid permeability in sand and gravel.	Medium or high shear strength; low to medium compressibility; medium to low permeability of compacted soil.	Seasonal high water table; rapid permeability. in substratum.	Low or moderate available water capacity; moderately deep rooting zone.	(2)	(2).
Poor: moderate shrink-swell potential in subsoil; bedded shale at 20 to 40 inches; limited material.	Unsuited	Fair if slopes are 6 to 9 percent, poor if slopes are 9 to 20 percent.	Moderate permeability to 20 inches; shale below; seepage hazard in fractured shale.	Bedded shale at 20 to 40 inches.	Moderate permeability; bedded shale at 20 to 40 inches.	Low or moderate available water capacity; slopes 6 to 20 percent; shale at 20 to 40 inches.	Fair stability; 20 to 40 inches to bedded shale.	Severe erosion hazard; low or moderate available water capacity.
Fair: moderate shrink-swell potential.	Unsuited	Good	Moderate permeability.	Medium or low shear strength; medium compressibility; low permeability of compacted soil.	Moderate permeability; concave swales that receive water from adjacent slopes.	High available water capacity; moderate water intake.	Concave swales; slopes generally less than 2 percent.	All features favorable.
Poor: high shrink-swell potential; poorly drained.	Unsuited	Poor: surface less than 8 inches thick.	Water table less than 4 feet in most years.	Medium to low shear strength; high compressibility; low permeability of compacted soil.	Slow permeability; subject to stream overflow; water table less than 4 feet in most years.	Poorly drained; claypan subsoil; water table; excess salts.	(2)	(2).
Poor: poorly drained; AASHTO group index more than 8.	Unsuited	Poor: thin surface; poorly drained.	Very slow permeability; good dugout site.	Medium to low shear strength; high compressibility; low permeability of compacted soil.	Very slow permeability; subject to frequent ponding.	Poorly drained; claypan subsoil; frequent ponding.	Flat poorly drained enclosed depressions; usually not applicable.	(2).
Good	Fair or poor below 16 inches depending on fines.	Good to 10 inches, sand and gravel substratum below.	Rapid permeability in substratum; high seepage.	Medium or high shear strength; low to medium compressibility; medium to low permeability of compacted soil.	Rapid permeability in substratum.	Low available water capacity; shallow rooting zone.	Rapid permeability in substratum; sand and gravel at 10 to 20 inch depth limits channel cuts.	Difficult to maintain; shallow to sand and gravel.

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill	Local roads and streets
Letcher: Lt	Severe: seasonal high water table; slow permeability in subsoil.	Severe: moderately rapid permeability in underlying material.	Moderate: seasonal high water table.	Severe or moderate: somewhat poorly or moderately well drained; seasonal high water table.	Severe: seasonal high water table; moderately rapid permeability in underlying material.	Moderate: 30 percent or more fines; moderate potential frost action.
Loamy Fluvaquents: Lv	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Moderate to severe: subject to flooding; moderate potential frost action.
Marsh: Mb. Severe limitations for most uses.						
Miranda Mapped only with Niobell soils.	Severe: very slow permeability.	Slight	Severe: claypan subsoil; difficult to excavate.	Moderate: moderate shrink-swell potential.	Moderate: clay loam subsoil and substratum.	Severe: AASHTO group index more than 8.
*Mondamin: MdA, MdB, Mh For Heil part of Mh, see Heil series.	Severe: moderately slow or slow permeability.	Slight if less than 2 percent slope; moderate if 2 to 6 percent slopes.	Moderate: silty clay loam and silty clay textures.	Severe: high shrink-swell potential.	Moderate: silty clay loam and silty clay textures.	Severe: AASHTO group index more than 8.
*Niobell: NmA, NpB For Miranda part of NmA, see Miranda series; for Noonan part of NpB, see Noonan series.	Severe: slow permeability.	Slight if slope is less than 2 percent; moderate if slope is 2 to 6 percent.	Moderate: clay loam subsoil and substratum.	Moderate: moderate shrink-swell potential.	Moderate: clay loam subsoil and substratum.	Severe: AASHTO group index more than 8.
Nishon Mapped only with Tonka and Williams soils.	Severe: slow permeability.	Severe: frequent ponding. Slight if water is not likely to enter or damage lagoon.	Severe: poorly drained; frequent ponding; clay subsoil.	Severe: high shrink-swell potential; frequent ponding.	Severe: frequent ponding; poorly drained; clay subsoil.	Severe: poorly drained; high shrink-swell potential; frequent ponding.
Noonan Mapped only with Niobell soils.	Severe: slow permeability.	Slight	Moderate: clay loam subsoil and substratum.	Moderate to severe: moderate to high shrink-swell potential.	Moderate: clay loam subsoil and substratum.	Severe: AASHTO group index more than 8.

interpretations—Continued

Suitability as source of—			Soil features affecting—					
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Fair: 30 percent or more fines.	Poor for sand; excess fines; unsuited for gravel.	Fair: surface less than 16 inches over claypan subsoil.	Moderately rapid permeability in underlying material; high seepage.	Medium or low shear strength; medium or high susceptibility to piping; fair or good compaction.	Slow permeability in subsoil; seasonal water table.	Slow permeability; salt accumulations in subsoil and substratum.	(2)	(2).
Fair: moderate shrink-swell potential.	Unsuited	Fair to good: loam texture.	Moderate permeability; potential seepage.	Medium to low shear strength; subject to piping.	Subject to flowing; moderate permeability.	High available water capacity; subject to flooding.	Channels subject to siltation; usually not applicable.	(2).
Poor: AASHTO group index more than 8.	Unsuited	Poor: thin layer over claypan subsoil.	Very slow permeability; low seepage.	Medium or low shear strength; medium compressibility.	Very slow permeability; claypan subsoil.	Very slow permeability; salt accumulations in subsoil and substratum.	(2)	(2).
Poor: AASHTO group index more than 8; high shrink-swell potential.	Unsuited	Poor: thin layer of silty clay loam over silty clay subsoil.	Moderately slow or slow permeability.	Medium or low shear strength; medium compressibility; low or medium susceptibility to piping.	Moderately slow or slow permeability.	Very slow intake rate; high available water capacity; nearly level to gently sloping.	Moderately slow or slow permeability.	Silty clay loam surface; moderately slow or slow permeability.
Poor: AASHTO group index more than 8.	Unsuited	Fair: surface less than 16 inches over compact clayey subsoil.	Moderately slow or slow permeability; low seepage.	Medium or low shear strength; medium compressibility; low permeability of compacted soil.	Slow permeability.	Slow permeability; salt accumulations in substratum.	Slopes less than 5 percent; slow permeability.	Loam surface; slow permeability.
Poor: high shrink-swell potential.	Unsuited	Poor: thin surface layer.	Slow permeability; subject to ponding.	High compressibility; low permeability of compacted soil; fair to poor compaction.	Slow permeability; subject to ponding, generally no outlets.	Subject to ponding; very slow intake rate; poorly drained.	(2)	(2).
Poor: AASHTO group index more than 8.	Unsuited	Fair: 10 inches of loam over claypan subsoil.	Slow permeability; low seepage.	Medium to low shear strength; medium compressibility; low permeability of compacted soil.	Slow permeability; compact claypan subsoil.	Very slow intake rate; claypan subsoil; high sodium content.	Most slopes are short and less than 5 percent; slow permeability.	Loam surface; slow permeability; cuts expose alkaline material.

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill	Local roads and streets
Parnell: Pa	Severe: slow permeability.	Severe: frequent ponding; slight if water is not likely to enter or damage lagoon.	Severe: very poorly drained; frequent ponding.	Severe: frequent ponding; high shrink-swell potential.	Severe: frequent ponding; very poorly drained; silty clay subsoil.	Severe: frequent ponding; very poorly drained; high potential frost action.
*Ranslo: Rh. For Harriet part of Rh, see Harriet series.	Severe: slow permeability.	Slight	Severe: seasonal high water table; subject to flooding.	Severe: seasonal high water table; subject to flooding.	Severe: seasonal high water table; subject to flooding.	Severe: subject to flooding; high shrink-swell potential; high potential frost action.
Regan: Rn	Severe: water table within 2 feet.	Severe: high water table.	Severe: very poorly drained; high water table.	Severe: very poorly drained; high water table.	Severe: very poorly drained; high water table.	Severe: very poorly drained; high susceptibility to frost action.
Spottswood: Sp	Moderate: seasonal high water table.[1]	Severe: rapid permeability in underlying material.[1]	Severe: sand and gravel below 20 inches; cutbanks cave.	Moderate or severe: somewhat poorly drained or moderately well drained.	Severe: rapid permeability in underlying materials; seasonal water table.	Moderate: moderate potential frost action.
Tally: TaB	Slight	Severe: moderately rapid permeability.	Severe: loamy fine sand substratum; cutbanks cave.	Slight	Severe: moderately rapid permeability.	Moderate: moderate potential frost action.
*Temvik: TbB, TgB, TgC. For Bryant part of TbB, see Bryant series; for Grassna part of TgB and TgC, see Grassna series.	Severe: moderately slow permeability in substratum.	Moderate if slope is less than 6 percent; severe if slope is more than 6 percent.	Moderate: clay loam substratum.	Moderate: moderate shrink-swell potential.	Moderate: clay loam substratum.	Moderate: moderate shrink-swell potential.

interpretations—Continued

Suitability as source of—			Soil features affecting—					
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Poor: very poorly drained; AASHTO group index more than 8; high shrink-swell potential.	Unsuited	Poor: very poorly drained.	Slow permeability; low seepage.	Medium or low shear strength; high compressibility; low permeability of compacted soil.	Slow permeability; subject to frequent ponding; generally no outlets.	Subject to ponding; very slow intake rate.	(2)	(2).
Poor: high shrink-swell potential.	Unsuited	Fair: surface less than 16 inches thick.	Water table 3 to 5 feet in most years.	Medium or low shear strength; medium or high compressibility; fair or poor compaction.	Slow permeability; subject to flooding; water table at 3 to 5 feet.	Subject to flooding; slow permeability; water table.	(2)	(2).
Poor: very poorly drained; high susceptibility to frost action.	Unsuited	Poor: very poorly drained.	Water table within 2 feet in most years.	Medium or low shear strength; medium or high compressibility; fair to poor compaction.	Moderate permeability; high water table.	High water table; very poorly drained.	(2)	(2).
Good	Fair or poor depending on amount of fines.	Good	Rapid permeability in underlying material; seasonal high water table.	Medium or high shear strength; fair or good compaction; susceptible to piping.	Rapid permeability in underlying material; seasonal water table.	Sand and gravel at 20 to 40 inches; low or moderate available water capacity.	(2)	(2).
Fair: moderate potential frost action.	Poor to unsuited: excess fines; no gravel.	Good	Moderately rapid permeability; high seepage.	Medium or low shear strength; low to medium compressibility; medium to high susceptibility to piping.	Moderately rapid permeability; well drained.	Moderate or low available water capacity; moderately rapid water intake rate; deep rooting zone.	(2)	(2).
Fair: moderate shrink-swell potential.	Unsuited	Good	Moderately slow permeability in underlying material.	Medium or low shear strength; medium compressibility; low to high susceptibility to piping.	Moderately slow permeability in substratum.	Slow water intake rate; high available water capacity.	Moderate permeability in subsoil; mostly smooth, plane or convex slopes.	Moderate erosion hazard; high available water capacity.

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill	Local roads and streets
*Tonka: Tn For Nishon part of Tn, see Nishon series.	Severe: slow permeability; subject to ponding.	Severe: frequent ponding; slight if water is not likely to enter or damage lagoon.	Severe: poorly drained; frequent ponding; silty clay subsoil.	Severe: high shrink-swell potential; poorly drained.	Severe: poorly drained; silty clay subsoil.	Severe: poorly drained; high shrink-swell potential; high potential frost action.
*Vida: VdC, VwC, VzE For Williams part of VwC, see Williams series; for Zahill part of VzE, see Zahill series.	Severe: moderately slow permeability in substratum.	Severe: most slopes more than 6 percent.	Moderate if slope is less than 15 percent; severe if slope is more than 15 percent.	Moderate if slope is less than 15 percent; severe if slope is more than 15 percent.	Moderate: clay loam subsoil and substratum.	Severe: AASHTO group index more than 8.
*Wabek: WaD, WbC For Bowdle part of WbC, see Bowdle series.	Moderate if slope is 6 to 15 percent; severe if slope is more than 15 percent.[1]	Severe: rapid permeability.	Severe: very shallow to sand and gravel.	Moderate if slope is 6 to 15 percent; severe if slope is more than 15 percent.	Severe: rapid permeability.	Moderate if slope is 6 to 15 percent; severe if slope is more than 15 percent.
*Williams: WnB, WnC, WtA, WtB, WvC. For Bowbells part of these units, see Bowbells series; for Nishon part of WtA and WtB, see Nishon series; for Parnell part of WvC, see Parnell series.	Severe: moderately slow permeability in substratum.	Slight if slope is less than 2 percent, moderate if 2 to 6 percent, severe if more than 6 percent.	Moderate: clay loam subsoil and substratum.	Moderate: moderate shrink-swell potential.	Moderate: clay loam subsoil and substratum.	Severe: AASHTO group index more than 8.
Zahill Mapped only with Vida soils.	Severe: moderately slow permeability in substratum.	Severe: hilly slopes.	Severe: hilly slopes.	Severe: hilly slopes.	Moderate: hilly slopes; clay loam substratum.	Severe: AASHTO group index more than 8.

[1] Possible source of pollution for domestic water supplies.

growth, and maintenance of plants and the layout and construction of the waterway.

Engineering test data

Tables 7 and 8 contain engineering test data for some of the soil series in Edmunds County. These tests were made to help evaluate 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. All tests were made by the South Dakota Department of Highways.

Table 7 contains data from soil samples of 7 soil profiles at specific locations in Edmunds County. The depth from which each sample was taken and the horizon designation are given. The moisture density column in this table has not been previously explained.

interpretations—Continued

Suitability as source of—			Soil features affecting—					
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Poor: poorly drained; high shrink-swell potential.	Unsuited	Poor: poorly drained.	Slow permeability; subject to ponding.	High compressibility; low permeability of compacted soil; fair to poor compaction.	Slow permeability; subject to ponding; generally no outlets.	Subject to ponding; very slow intake rate; poorly drained.	[2]	[2].
Poor: AASHTO group index more than 8.	Unsuited	Fair if slope is less than 15 percent; poor if slope is more than 15 percent.	Moderately slow permeability in substratum.	Medium to low shear strength; medium compressibility; low permeability of compacted soil.	Moderately slow permeability in substratum.	Short convex slopes mostly more than 6 percent.	Mostly short, convex slopes.	High available water capacity; severe erosion hazard.
Good if slope is 6 to 15 percent; fair if slope is more than 15 percent.	Good to poor depending on fines.	Poor: thin surface layer over sand and gravel.	Rapid permeability; high seepage.	Medium or high shear strength; medium low to compressibility; medium to low permeability of compacted soil.	Rapid permeability in substratum.	Very low or low available water capacity; very shallow rooting zone; slopes more than 6 percent.	Very short, convex slopes.	Very shallow to sand and gravel; very low or low available water capacity.
Poor: AASHTO group index more than 8.	Unsuited	Good in upper 4 inches, fair below; clay loam texture.	Moderately slow permeability in substratum.	Medium or low shear strength; medium compressibility; fair or good compaction.	Moderately slow permeability in substratum.	High available water capacity; slow water intake rate; deep rooting zone; irregular slopes.	Slopes are generally short and convex; moderately slow permeability in substratum.	High available water capacity; erosion hazard on slopes.
Poor: AASHTO group index more than 8.	Unsuited	Poor: thin surface layer; hilly slopes.	Moderately slow permeability in substratum; hilly slopes.	Medium or low shear strength; medium compressibility; fair or good compaction.	Hilly slopes	Not suitable; hilly slopes.	Slopes are hilly and convex.	Severe erosion hazard; hilly slopes.

[2] Practice generally not applicable.

Compaction or moisture density data are important in earthwork. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material increases until the *optimum moisture content* is reached. After that, density decreases with increase in moisture content. The highest dry density obtained in the compactive test is termed *maximum dry density*. As a rule, maximum strength of earthwork is obtained if the soil is compacted to the maximum dry density.

Table 8 is a summary of engineering tests made on samples collected along proposed highway routes in Edmunds County and adjacent areas. The samples were taken at depths that reflect major contrasts in color and texture, but some samples include material from more than one major horizon. Because of the difference in sampling, the range in properties shown in table

TABLE 7.—*Engineering*

[Tests performed by the South

Soil name	Parent material	Depth	Moisture density [1]	
			Maximum dry density	Optimum moisture
			Lb per cu ft	*Pct*
Bowdle loam:				
462 feet east and 102 feet south of northwest corner of sec. 6, T. 122 N., R. 73 W. (Modal)	Alluvium.	7–16	110	16
		19–23	108	18
		23–60	116	14
Bryant loam:				
138 feet west and 736 feet south of northeast corner of sec. 20, T. 124 N., R. 73 W. (Modal)	Silty glacial drift.	6–14	100	19
		18–49	112	15
		49–60	111	18
Grassna loam:				
1,104 feet east and 153 feet north of south quarter corner of sec. 25, T. 122 N., R. 66 W. (Modal)	Alluvium.	7–13	96	21
		19–36	106	18
		43–60	117	14
Heil silt loam:				
291 feet north and 252 feet west of southeast corner of sec. 16, T. 123 N., R. 71 W. (Modal)	Glacio-lacustrine sediments.	9–25	91	29
		25–52	93	27
		52–60	102	20
Niobell loam:				
810 feet east and 123 feet north of southwest corner of sec. 16, T. 123 N., R. 66 W. (Modal)	Glacial till.	11–18	105	18
		23–41	111	17
		41–60	109	17
Parnell silty clay loam:				
315 feet east and 84 feet south of northwest corner of sec. 12, T. 121 N., R. 66 W. (Modal)	Local alluvium.	6–33	91	25
		38–60	92	22
Williams loam:				
87 feet east and 89 feet south of northwest corner of sec. 24, T. 123 N., R. 70 W. (Modal)	Glacial till.	5–14	104	18
		19–33	105	19
		33–60	109	18

[1] Based on AASHTO Designation T 99, Method A (*1*).

[2] Mechanical analysis according to AASHTO Designation: T 88. Results by this procedure frequently may differ somewhat from cedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the pipette method and the material coarser than 2 millimeters is excluded from calculations of grain-size fractions. The mechanical

[3] Based on AASHTO Designation M 145–49.

8 may differ from those given for the same series in table 5.

Formation and Classification of the Soils

This section describes the major factors of soil formation as they relate to the soils of Edmunds County. It also explains the system of classifying soils in broader categories.

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 the physical and mineralogical composition of the parent material, the climate under which the soil material has been accumulated and existed since accumulation, the plant and animal life on and in the soil, the relief, or lay of the land, and the length of time 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

test data

Dakota Department of Highways]

Mechanical analysis [2]					Liquid limit	Plasticity index	Classification	
Percentage passing sieve—				Percentage smaller than 0.005 mm			AASHTO [3]	Unified
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)					
					Pct			
99	97	84	59	20	34	11	A-6(5)	CL
96	89	65	31	17	28	6	A-2-4(0)	SM-SC
89	80	41	11	2	21	1	A-1-6(0)	SW-SM
	100	99	93	29	37	12	A-6(9)	ML or CL
	100	99	93	27	33	11	A-6(8)	CL
	100	99	94	21	35	13	A-6(9)	CL
	100	96	79	29	40	15	A-6(10)	ML or CL
	100	96	79	33	39	17	A-6(11)	CL
100	99	93	67	20	29	10	A-4(6)	CL
		100	98	57	61	32	A-7-6(20)	CH
		100	97	55	59	32	A-7-6(20)	CH
		100	98	41	47	21	A-7-6(13)	CL
	100	94	67	31	37	14	A-6(7)	CL
97	95	87	62	35	38	20	A-6(9)	CL
98	97	90	70	38	41	20	A-7-6(11)	CL
	100	99	97	51	54	26	A-7-6(17)	CH
	100	99	98	49	61	33	A-7-6(20)	CH
100	99	94	67	32	39	15	A-6(8)	CL
	100	99	80	33	36	15	A-6(10)	CL
99	98	92	70	32	44	24	A-7-6(14)	CL

results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO pro- the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by analysis data in this table are not suitable for naming textural classes for soil.

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 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 [9]

Parent material is the unconsolidated mass in which a soil formed. Glacial deposits of Late Wisconsin age cover all of Edmunds County. The ice sheet moved into the county from the north carrying large amounts of soil and rock material that ranged in size from clay to large boulders. When the climate warmed, the retreating ice sheet left several kinds of glacial material deposited on the landscape of Edmunds County. These include glacial till, silty glacial drift, outwash sand and gravel, and lacustrine sediments. Of these materials glacial till and glacial drift are the most extensive and relate to the two physiographic areas of the county, the Missouri Coteau and the Drift Prairie.

The Missouri Coteau is in the western two-thirds of the county and has landforms that are characteristic of glacial stagnation (fig. 17). These landforms include dead-ice moraines, ice-walled lake plains, and circular disintegration ridges or "doughnuts" (*2*). Relief in this area is mostly undulating to hilly. The drainage

[9] JAMES R. MONAGHAN, geologist, Soil Conservation Service, helped prepare this section.

TABLE 8.—*Engineering test data for soil*

[Tests were made by the South Dakota Department of

Soil series	Horizon	Number of samples tested	Mechanical analysis [1]					
			Percentage less than 3 inches passing sieve—					
			No. 10 (2.0 mm)		No. 40 (0.42 mm)		No. 200 (0.074 mm)	
			Range	Average	Range	Average	Range	Average
Bowbells.	A	8	97–100	99	90–98	94	72–84	78
	B	20	95–100	98	88–100	94	62–90	76
	C	6	94–100	97	89–96	93	64–82	73
Cresbard.	A	12	95–100	99	88–100	94	54–85	70
	B	24	94–100	98	87–100	94	62–95	78
	C	26	92–100	96	84–97	90	44–88	66
Divide.	B	1	----------	89	----------	75	----------	50
	C	2	48–100	80	28–94	61	21–60	41
	2C	8	26–100	68	11–100	56	0–87	39
Harriet.	A	1	----------	100	----------	98	----------	81
	B	5	99–100	100	97–100	99	89–98	94
	C	10	97–100	99	92–100	97	74–100	88
Heil.	A	1	----------	97	----------	90	----------	68
	B	4	94–100	98	85–100	93	61–97	79
Letcher.	A	1	----------	98	----------	88	----------	51
	B	3	41–100	78	18–100	62	16–62	39
	C	4	74–100	94	57–100	82	9–54	31
Miranda.	A	1	----------	99	----------	96	----------	82
	B	5	97–100	99	91–100	96	72–97	84
	C	11	94–100	98	80–100	92	61–97	79
Mondamin.	A	8	98–100	99	94–100	97	77–99	88
	B	15	96–100	99	91–100	97	75–100	88
	C	1	----------	100	----------	99	----------	96
Niobell.	A	5	92–100	97	88–96	92	59–73	66
	B	10	97–100	99	90–99	95	60–94	77
	C	3	96–100	98	87–97	92	56–76	66
Noonan.	B	4	----------	100	----------	97	61–97	69
	C	4	95–100	98	88–98	93	55–90	73
Parnell.	A	3	90–100	97	88–100	95	70–99	84
	B	16	95–100	99	87–100	96	66–100	85
	C	17	93–100	97	83–100	92	63–97	80
Spottswood.	A	12	75–100	94	50–100	81	31–89	60
	B	15	61–100	86	27–100	68	13–83	48
	C	4	55–100	87	14–100	72	6–100	55
	2C	12	35–89	62	9–70	40	6–34	20
Temvik.	A	8	99–100	100	96–100	99	90–100	95
	B	11	98–100	99	92–100	98	70–100	88
	C	8	98–100	99	93–99	96	69–95	82
	2C	10	97–100	99	95–100	99	86–100	95
Tonka.	A	11	97–100	99	90–100	95	58–97	77
	B	19	93–100	97	86–100	94	68–100	84
	C	10	76–100	95	55–100	88	39–100	77
Williams.	A	113	90–100	96	81–99	90	51–83	67
	B	220	91–100	96	82–98	90	55–82	69
	C	417	89–100	95	79–96	88	53–79	66
	2C	17	66–100	89	38–100	76	7–100	55

[1] Mechanical analysis according to AASHTO Designation: T 88. Results by this procedure may differ somewhat from the results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by hydrometer method and the various grain-size fractions are calculated on the basis of all the material up to and including that 3 inches 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 the calculations of grain-size fractions. The mechanical analyses data in this table are not intended for naming textural classes of soil.

samples taken along proposed highway routes

Highways. Dashed lines indicate no data available]

Percentage smaller than 0.005 mm		Liquid limit [2]		Plasticity index [3]		Classification			Estimated CBR [6]
Range	Average	Range	Average	Range	Average	AASHTO [4] (Old index)	AASHTO [5] (New index)	Unified	
20–40	30	35–53	44	12–25	18	A–7–6(12)	A–7–6(15)	CL–ML	4
24–47	35	37–48	42	14–29	21	A–7–6(13)	A–7–6(16)	CL	5
31–44	37	36–48	42	19–30	24	A–7–6(16)	A–7–6(16)	CL	5
20–38	28	32–49	41	10–24	17	A–7–6(10)	A–7–6(11)	CL–ML	5
23–58	40	36–62	49	17–41	28	A–7–6(17)	A–7–6(23)	CL	3
12–52	31	17–64	41	1–42	21	A–7–6(11)	A–7–6(12)	CL	5
----------	23	----------	33	----------	15	A–6(5)	A–6(4)	SC	7
3–35	19	35–42	39	10–17	13	A–6(2)	A–6(2)	SM–SC	5
0–54	20	7–63	35	0–34	15	A–6(2)	A–6(2)	SC	6
----------	22	----------	46	----------	17	A–7–6(12)	A–7–6(15)	CL–ML	4
17–90	53	38–104	71	14–65	39	A–7–6(20)	A–7–5(44)	MH–CH	1
28–67	47	38–75	57	19–48	33	A–7–6(19)	A–7–6(32)	CH	3
----------	22	----------	48	----------	19	A–7–6(12)	A–7–6(13)	CL–ML	4
18–53	35	38–45	42	19–27	23	A–7–6(14)	A–7–6(18)	CL	5
----------	19	----------	36	----------	11	A–6(4)	A–6(3)	CL–ML	6
16–31	18	23–69	46	4–36	20	A–7–6(3)	A–7–6(3)	SM–SC	4
6–26	15	15–34	24	0–21	9	A–2–4(0)	A–2–4(0)	SC	----------
----------	37	----------	42	----------	14	A–7–6(10)	A–7–6(13)	CL–ML	5
0–68	33	49–58	53	19–34	26	A–7–6(17)	A–7–6(24)	MH–CH	3
22–57	39	36–75	55	21–41	31	A–7–6(19)	A–7–6(29)	CH	3
23–60	41	36–54	45	11–25	17	A–7–6(12)	A–7–6(18)	CL–ML	4
38–69	53	41–61	51	20–41	30	A–7–6(18)	A–7–6(29)	CH	2
----------	59	----------	52	----------	27	A–7–6(17)	A–7–6(30)	CH	3
22–30	26	32–46	39	13–21	17	A–6(9)	A–6(10)	CL	5
32–44	38	41–50	46	24–29	26	A–7–6(16)	A–7–6(20)	CL	4
25–40	32	32–49	41	15–35	25	A–7–6(12)	A–7–6(14)	CL	5
6–64	35	24–95	60	0–57	28	A–7–5(19)	A–7–5(25)	MH	2
29–54	41	35–50	42	20–32	26	A–7–6(14)	A–7–6(17)	CL	5
25–44	34	45–51	48	10–29	19	A–7–6(14)	A–7–6(19)	CL–ML	4
20–64	42	41–73	57	15–47	30	A–7–6(19)	A–7–6(29)	CH	3
18–69	43	35–63	49	13–38	25	A–7–6(16)	A–7–6(21)	CL	3
4–39	21	36–55	45	13–25	19	A–7–6(9)	A–7–6(10)	CL–ML	4
4–37	20	32–50	41	11–29	20	A–7–6(6)	A–7–6(6)	SC	5
4–44	24	33–52	42	16–25	20	A–7–6(8)	A–7–6(8)	CL	5
0–15	6	15–34	24	0–15	7	A–2–4(0)	A–2–4(0)	SM–SC	----------
19–35	26	33–44	39	9–20	14	A–6(10)	A–6(15)	CL–ML	5
24–38	30	30–46	38	9–27	18	A–6(11)	A–6(16)	CL	6
25–56	40	30–82	56	13–51	31	A–7–6(19)	A–7–6(28)	CH	3
19–39	29	31–46	39	7–26	16	A–6(10)	A–6(17)	CL–ML	5
14–45	29	32–57	44	7–28	17	A–7–6(12)	A–7–6(14)	CL–ML	4
31–60	45	41–61	51	19–38	28	A–7–6(18)	A–7–6(25)	CH	3
14–72	43	26–66	46	8–40	23	A–7–6(15)	A–7–6(18)	CL	4
11–35	23	30–49	40	9–21	15	A–6(8)	A–6(9)	CL–ML	5
18–42	30	32–46	39	12–26	19	A–6(10)	A–6(11)	CL	5
19–43	30	28–49	39	10–30	19	A–6(10)	A–6(11)	CL	5
0–55	26	0–81	39	0–47	20	A–6(8)	A–6(8)	CL	5

[2] Based on AASHTO Designation T 89–60.
[3] Based on AASHTO Designation T 90–61.
[4] Based on AASHTO Designation M 145–49.
[5] Based on AASHTO Designation M 145–66I.
[6] Estimated values based on relationships between California Bearing Ratio and liquid limit.

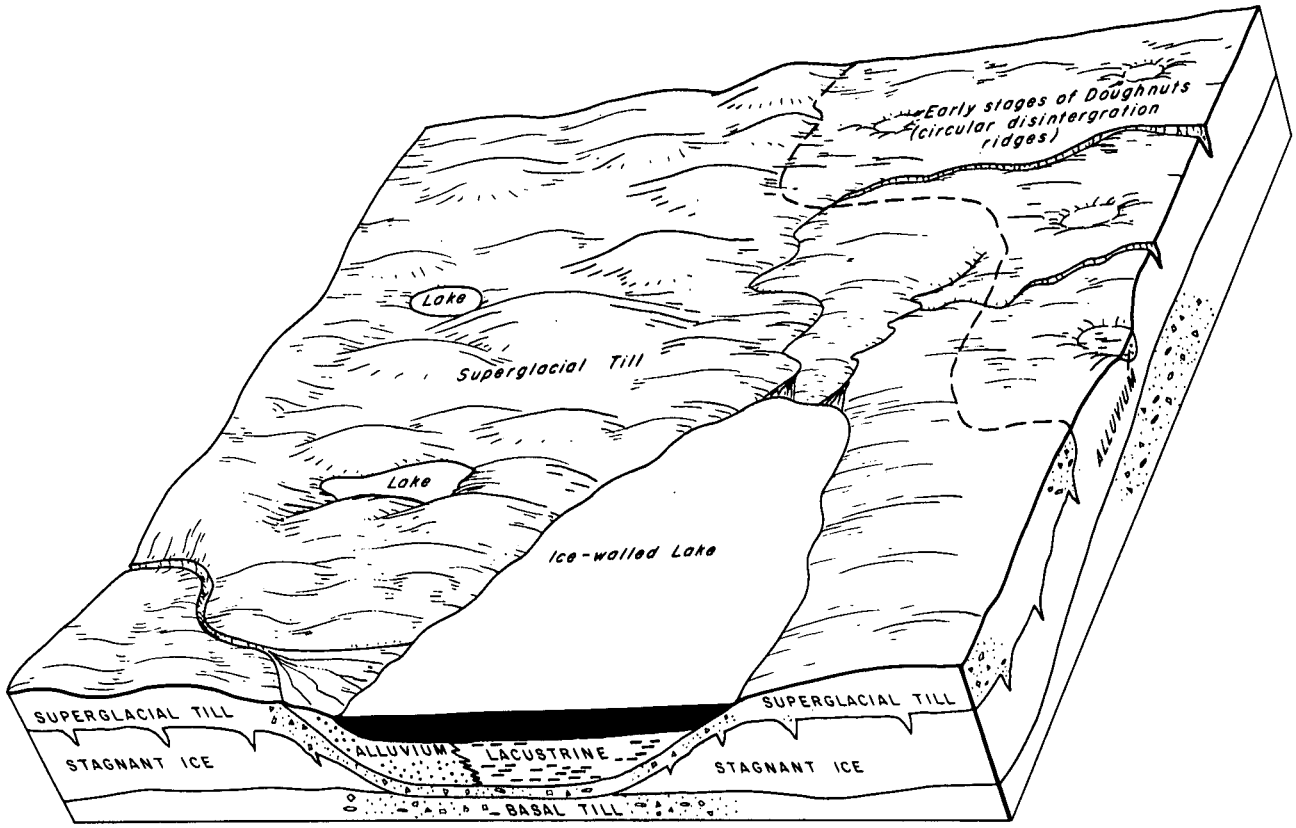
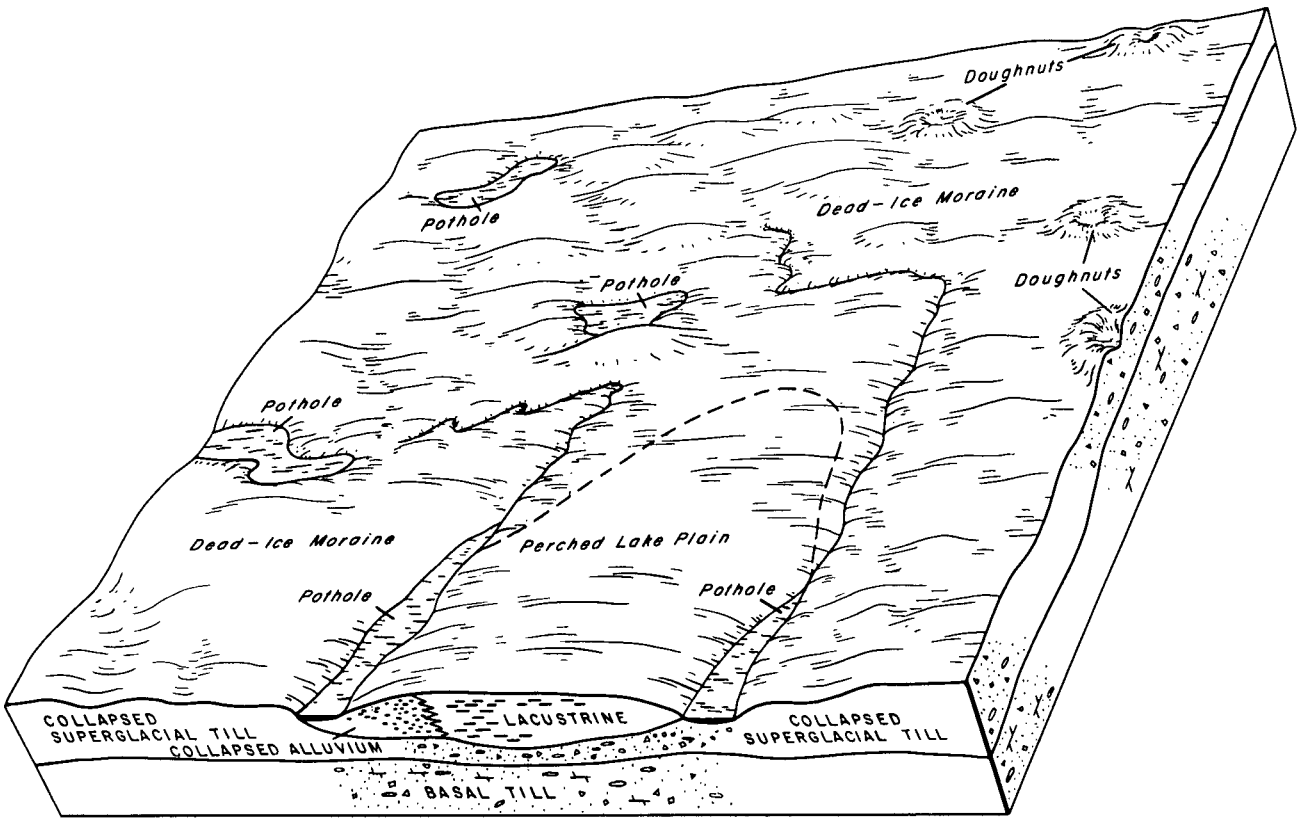


Figure 17.—Top: Missouri Coteau landscape during glacial period. Bottom: Same landscape today.



pattern is poorly defined and potholes, or closed depressions, are numerous. The glacial till in this area is an unassorted mixture of silt, clay, sand, and gravel in proportions that differ from one place to another. Cobbles and stones commonly are scattered throughout the till. Niobell, Vida, Williams, and Zahill soils are examples of soils formed in glacial till.

Within the Missouri Coteau area are two other kinds of glacial deposits, glacial outwash and glacial lacustrine. The glacial outwash consists of stratified sand and gravel that was deposited on nearby landscapes by large volumes of meltwater from the retreating glacier. Bowdle, Lehr, Spottswood, and Wabek soils formed in or are underlain by glacial outwash.

Much of the running water from the melting glacier collected in glacial lakes that were ice-walled and surrounded by superglacial till resting on stagnant ice. The subsequent subsiding of the surrounding areas drained the lakes and resulted in perched lake plains. The lacustrine sediments deposited in these glacial lakes were mostly silt and clay and are the materials in which Mondamin soils formed.

The Drift Prairie is in the eastern one-third of the county and has ground moraine and end moraine landforms typical of a gradually retreating glacier. The combined action of wind and water sorted the glacial debris and redeposited these materials. The relief is nearly level to undulating. Slopes commonly are longer, the drainage pattern is better defined, and potholes are less numerous than on the Missouri Coteau. The glacial drift deposited on these landscapes shows some evidence of stratification and contains a high percentage of very fine sand and silt. A few pebbles are scattered throughout this material, but otherwise the glacial drift is relatively free of stones and boulders. Soils of the Bryant and Temvik series formed entirely or in part in glacial drift.

Alluvium of Recent age is the principal other kind of parent material in which soils of Edmunds County formed. Harriet and Ranslo soils formed in alluvium deposited by streams. Bowbells and Grassna soils formed in alluvium washed in from adjacent soils and deposited in swales. Parnell and Tonka soils are examples of soils formed in alluvium washed in from higher areas and deposited in potholes, or closed depressions.

Climate

Edmunds County has a continental climate that has cold winters and hot summers. The average annual precipitation is about 18 inches, of which about 80 percent falls during the growing season. The average annual air temperature is about 43° F. This climate has favored the accumulation of organic matter in the surface layer of the soils, the migration of clay minerals into the subsoil, and the leaching of carbonates to a depth averaging about 16 inches. Alternate periods of wetting and drying and seasonal freezing and thawing affect the contraction and expansion of the clay minerals in the soil mass. The process of freezing and thawing also contributes to the weathering of stone fragments. Because the climate is relatively uniform throughout the county, the contrasts in the kinds of soils in Edmunds County have not been caused by climate. Additional climatic data are given in the section "Environmental Factors Affecting Soil Use."

Plant and animal life

Plants, animals, insects, earthworms, bacteria, and fungi are important in soil formation. The kinds and amounts of plants under which the soils formed affect the content of organic matter in the surface layer and the amounts of nutrients in the soil. Earthworms and burrowing animals help keep the soil open and porous. Bacteria and fungi help decompose the plant residues changing the organic matter into the more stable humus as well as releasing nutrients for plant food.

The natural vegetation of the county was mainly mid and tall grasses. Consequently, the soils in the county are moderate to high in content of organic matter and medium to high in fertility and have granular structure in the surface layer.

Relief

Relief influences soil formation through its affect on drainage and runoff which in turn affect plant cover, biological activity, soil temperature, rate of erosion, and the deposition of sediments. The Bowbells, Parnell, Vida, Williams, and Zahill soils formed in similar materials but have differences that are associated with relief.

The Zahill soil is hilly to steep and loses much of the rainfall because of rapid runoff. Natural erosion is active, and the small amount of rainfall that enters the soils limits plant growth mainly to short grasses. Because of this limitation, the Zahill soil is low in content of organic matter and is calcareous at or near the surface. The Vida and Williams soils are less steep and more of the rainfall enters the soil. As a result, these soils have more distinct horizons of organic matter accumulation and have carbonates leached downward from the upper horizons.

The Bowbells soils, in swales, receive runoff from adjacent uplands and have a favorable moisture regime. They have thicker A and B horizons than Vida and Williams soils and also are leached of carbonates to greater depths. Parnell soils are in closed depressions. They are leached of carbonates to a greater depth than any of the above-named soils. They have colors and mottles characteristic of very poorly drained soils.

Time

The length of time that the forces of climate, plant and animal life, and relief have had to act on the parent material is reflected in the different kinds of soils in the county. The landscapes in Edmunds County are all relatively young, dating back only to the glacial period. The well-drained Williams soils are among the most mature soils in the county. These soils have distinct horizons of organic matter accumulation, distinct increases of clay content in their B horizons, and leaching of carbonates into the lower part of the B or the C horizons. The youngest soils in the county are those formed in recent alluvium, such as the alluvial soils mapped as Loamy Fluvaquents.

Classification of Soils

Soils are classified so that we can more easily re-

TABLE 9.—*Classification of the soils*

Series	Family	Subgroup	Order
Bearden	Fine-silty, frigid	Aeric Calciaquolls	Mollisols.
Bowbells	Fine-loamy, mixed	Pachic Argiborolls	Mollisols.
Bowdle	Fine-loamy over sandy or sandy-skeletal, mixed	Pachic Haploborolls	Mollisols.
Bryant	Fine-silty, mixed	Typic Haploborolls	Mollisols.
Cresbard	Fine, mixed	Glossic Udic Natriborolls	Mollisols.
Divide	Fine-loamy over sandy or sandy-skeletal, frigid	Aeric Calciaquolls	Mollisols.
Edgeley	Fine-loamy, mixed	Udic Haploborolls	Mollisols.
Grassna	Fine-silty, mixed	Pachic Haploborolls	Mollisols.
Harriet	Fine, mixed, frigid	Typic Natraquolls	Mollisols.
Heil	Fine, montmorillonitic, frigid	Typic Natraquolls	Mollisols.
Lehr	Fine-loamy over sandy or sandy-skeletal, mixed	Typic Haploborolls	Mollisols.
Letcher	Coarse-loamy, mixed	Udic Natriborolls	Mollisols.
Miranda	Fine-loamy, mixed	Leptic Natriborolls	Mollisols.
Mondamin	Fine, montmorillonitic	Typic Argiborolls	Mollisols.
Niobell	Fine-loamy, mixed	Glossic Natriborolls	Mollisols.
Nishon	Fine, montmorillonitic, frigid	Typic Albaqualfs	Alfisols.
Noonan	Fine-loamy, mixed	Typic Natriborolls	Mollisols.
Parnell	Fine, montmorillonitic, frigid	Typic Argiaquolls	Mollisols.
Ranslo	Fine, montmorillonitic, frigid	Typic Natraquolls	Mollisols.
Regan	Fine-silty, frigid	Typic Calciaquolls	Mollisols.
Spottswood	Fine-loamy over sandy or sandy-skeletal, mixed	Pachic Udic Haploborolls	Mollisols.
Tally	Coarse-loamy, mixed	Typic Haploborolls	Mollisols.
Temvik	Fine-silty, mixed	Typic Haploborolls	Mollisols.
Tonka	Fine, montmorillonitic, frigid	Argiaquic Argialbolls	Mollisols.
Vida	Fine-loamy, mixed	Typic Argiborolls	Mollisols.
Wabek	Sandy-skeletal, mixed	Entic Haploborolls	Mollisols.
Williams	Fine-loamy, mixed	Typic Argiborolls	Mollisols.
Zahill	Fine-loamy, mixed (calcareous), frigid	Typic Ustorthents	Entisols.

member 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 the 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 (*9*).

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 grouped. The same property or subdivisions of this property may be used in several different categories. In table 9, the soil series of Edmunds County are placed in 3 categories of the current system. Classes of the current system are briefly defined in the following paragraphs.

ORDER: Ten soil orders are recognized. The properties 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. Each order is named with a word of three or four syllables ending in *sol* (Moll-i-sol).

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. The names of suborders have two syllables. The last syllable indicates the order. An example is *Aquoll* (*Aqu*, meaning water or wet, and *oll*, from Mollisol).

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. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is *Haplaquoll* (*Hapl*, meaning simple horizons, *aqu*, for wetness or water, and *oll*, from Mollisols).

SUBGROUP: Great groups are subdivided into sub-

groups, 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. Other subgroups may have soil properties unlike those of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is *Typic Haplaquolls* (a typical Haplaquoll).

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. A family name consists of a series of adjectives, preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on, that are used as family differentiae (see table 9). An example is the coarse-loamy, mixed, mesic family of Typic Haplaquolls.

Environmental Factors Affecting Soil Use

This section describes the natural and cultural features in Edmunds County that affect the use and management of soils.

Geology

All of Edmunds County is within the glaciated part of the Northern Great Plains. Much of the county is covered by unassorted drift or glacial till that is clay loam or heavy loam. Stratified silty drift is mainly in the eastern part of the county, but small scattered areas occur elsewhere.

Deposits of glacial outwash are mainly in the western part of the county and are a source of sand and gravel for construction and road uses. Sand and gravel deposits are scarce in the eastern part of the county and are mostly near the larger drainageways.

Relief

Relief ranges from nearly level to hilly. The soils are mostly nearly level to gently sloping in the eastern part of the county where elevation differences range from 10 to 30 feet. They are gently undulating to hilly in the central and western parts of the county where elevation differences range to as much as 100 feet. The steepest slopes are in the Williams-Vida soil association. Elevations above sea level range from 1,330 feet in the southeastern part of the county to 2,040 feet near the town of Bowdle on the west side of the county.

Climate[10]

Edmunds County has a continental climate that is characterized by cold winters and hot summers. Usually the precipitation is light in winter and comes as snow. The growing season precipitation is about 80 percent of the total annual precipitation.

[10] By WILLIAM F. LYTLE, South Dakota State University.

The climatic summary for Edmunds County is based on data recorded by cooperative observers of the National Oceanic and Atmospheric Administration at Ipswich and Roscoe in the central part of the county. The elevation at Ipswich is 1,541 feet and at Roscoe is 1,829 feet. The data is for the period 1941–70. There is a slight climatic gradient from east to west across the county, but the climate at Ipswich and Roscoe is representative for the county. Climate is a limiting factor in the production of most crops in the county.

The temperature range from summer to winter, and at times from day to day, is large in the county. Summer temperatures climb above 90° F on an average of 21 days in a year. Temperatures above 100° occur 3 days a year. The warmest summer month during the period 1941–70 was July 1966, when the average maximum temperature was 90.4° and the average minimum temperature was 62.5°. In winter, the minimum temperature drops to 20° below zero or lower about 5 times a year. Temperatures of 30° below zero occur about once in two years. The coldest month during the period 1941–70 was January 1950, when the average maximum temperature was 5.8°, and the average minimum temperature was 13.5° below zero. There are about 42 days a year when the minimum temperature drops below zero.

Data on temperature and precipitation are given by month in table 10. The least amount of precipitation was in 1952 when the annual precipitation was 8.62 inches, and the greatest amount was in 1968 when 24.88 inches was recorded. Growing season precipitation ranged from 5.60 inches in 1952 to 21.15 inches in 1968. Most of the rainfall during the growing season comes from thunderstorms of widely differing intensity. About once a year, rainfall of 1 inch falls in one hour; about once in 12 years, 2 inches of rain falls in one hour; 2 inches fall in 24 hours once in 2 years; and a 3-inch rainfall in 24 hours occurs about once in 5 years.

Table 11 gives the probabilities of specified temperatures after certain dates in the spring and below certain dates in the fall. This table shows the probability is 50 percent, or 5 years out of 10, that a temperature of 32° or lower will occur on or after May 14.

Similarly, table 11 shows the probability is 50 percent that a temperature of 32° will occur on or before September 26. Using these two dates, it can be said that the average length of the growing season is 135 days.

The average annual snowfall at Roscoe is 27.4 inches. Snow cover protects fields and pastures, but a heavy cover usually delays farming operations in the spring. The smallest amount of snowfall during the years 1941–70 was 17.5 inches in 1942, and the greatest snowfall was 52.6 inches in 1950. The average number of days that have a snow cover of 1 inch or more is 50 days in a year, but it has ranged from as little as 5 days in 1946 to 125 days in 1952. The greatest snowfall in one day was on May 5, 1950, when 17 inches fell. Strong winds in the winter cause the depth of snow cover to be greater in sheltered places and less on open fields that have little or no vegetative cover or crop residue.

In an average year sunshine can be expected about 60 percent of the time. The greatest amount of sun-

TABLE 10.—*Temperature and precipitation*

[Based on data recorded at Ipswich and Roscoe, South Dakota, 1941–70]

Month	Temperature				Precipitation							
			2 years in 10 will have—					1 year in 10 will have—			Average number of days with—	
	Average daily maximum	Average daily minimum	Average daily maximum equal to or higher than—	Average daily minimum equal to or lower than—	Average total	Maximum total	Minimum total	Less than—	More than—	Average snowfall	Snowfall of 1 inch or more	Snow cover of 1 inch or more
	°F	°F	°F	°F	In	In	In	In	In	In		
January	22.2	0.6	33.5	−7.4	0.42	1.29	(1)	0.059	0.901	5.5	5	13
February	28.1	4.9	36.2	−1.7	.50	2.06	(1)	.092	1.021	5.2	2	12
March	38.6	16.3	47.9	8.8	.77	3.26	.06	.161	1.571	6.0	2	9
April	57.6	31.7	64.2	27.5	1.94	6.67	.16	.465	3.856	2.0	(2)	(2)
May	69.7	42.6	74.7	38.6	2.67	5.33	.38	1.017	4.694	1.0	(2)	(2)
June	78.1	52.8	83.6	49.8	4.02	7.46	.64	1.893	6.533		0	0
July	85.9	57.8	90.3	54.8	2.46	4.83	.56	1.014	4.835		0	0
August	85.7	56.0	90.3	53.3	2.02	4.54	(1)	.707	3.604		0	0
September	75.0	45.2	79.0	42.4	1.50	4.51	.15	.371	2.961		(2)	(2)
October	63.0	34.6	69.0	30.8	1.02	3.04	(1)	.118	2.261	.2	(2)	(2)
November	42.4	20.0	49.3	14.3	.68	3.07	(1)	.035	1.598	2.9	1	5
December	28.2	7.2	35.7	.7	.35	1.44	(1)	.032	.750	4.6	2	10
Year	56.2	30.8			18.35	[3] 24.88	[4] 8.62	14.71	22.72	27.4	12	50

[1] Trace.

[2] Less than 0.5 day.

[3] In 1968.

[4] In 1952.

TABLE 11.—*Probabilities of last freezing temperatures in spring and first in fall*

[Based on data recorded at Roscoe, South Dakota, 1941–70]

Probability	Dates for given probability and temperature					
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower	36° F. or lower
After a specified date in spring:						
90 percent	March 12	March 20	March 31	April 12	April 25	May 5
70 percent	March 20	March 29	April 9	April 20	May 2	May 12
50 percent	April 2	April 14	April 23	May 3	May 14	May 23
30 percent	April 15	April 19	May 6	May 16	May 26	June 3
10 percent	April 22	May 8	May 15	May 24	June 2	June 10
Before a specified date in fall:						
10 percent	October 14	October 6	September 24	September 15	September 7	August 20
30 percent	October 24	October 13	October 1	September 22	September 14	August 31
50 percent	November 4	October 24	October 12	October 3	September 26	September 18
70 percent	November 15	November 4	October 23	October 14	October 7	October 7
90 percent	November 21	November 10	October 30	October 21	October 14	October 7

shine is in July and August when sunshine can be expected 75 percent of the time.

Windspeed averages about 11 miles per hour in summer when the prevailing wind is from the southeast. During winter the wind averages 14 miles per hour and the prevailing direction is from the northwest. A windspeed of more than 50 miles per hour can occur during any month but is more likely to occur in the summer accompanying thunderstorms. Thunderstorms occur on an average of about 40 to 45 days per

year. Hail occasionally accompanies the thunderstorms and can be expected about twice in a year. Hail is most likely to fall in July.

The relative humidity differs widely from early morning to afternoon and from day to day. The annual average is about 80 percent in the morning and 60 percent in the afternoon.

The potential water loss from soil and crops is indicated by the loss from an evaporation pan. The average annual evaporation from a standard "class A pan" in this county is about 47 inches. An average of about 39 inches evaporates during May through October. The average annual rate of evaporation from small lakes is about 35 inches; and the water loss from soil and crops generally is less, depending upon the available soil moisture.

Water

The principal surface water resources are those waters in a few small lakes, open water in areas of Marsh, and intermittent waters ponded in potholes. Dugouts constructed on the edges of the potholes provide much of the livestock water needs in pastures. Preachers Run and Snake Creek in the eastern part of the county are the main streams. Streamflow is greatest in these creeks and their tributaries during March and April from snowmelt and in May and June from precipitation runoff. These streams are dry during periods of low rainfall. Lake Parmley on Snake Creek, Rosette Dam, and Staffords Dam are the main impoundments that store streamflow.

Ground water from wells is available in most parts of the county. Shallow wells ranging in depth from 15 to 100 feet have their source of water in the glacial deposits. Deep wells have their source of water in sandstones that are at depths ranging from 1,200 to 1,500 feet (*6*). Generally, the deep waters are under artesian pressure and some of these wells flow at the surface. Water quantity generally is greater in the deep wells, but the water quality is poorer than that in the shallow wells. None of these aquifers have enough water to meet the needs of large-scale irrigation systems.

Natural Vegetation

Most of the county is on the eastern side of the mixed grass prairie region (*4*). However, the eastern part of the county is in a transition area between the mixed grass prairie to the west and the tall grass prairie further to the east. The treeless aspect of the prairie was very apparent when the first settlers arrived. The lack of trees was probably because of uncontrolled prairie fires and periodic summer droughts.

The original plant cover was mostly mid and tall grasses. Because of stress caused by overgrazing especially during drought periods, tall grasses now are mainly in the more favorable moisture positions. Mid and short grasses now dominate most of the native pastures.

Transportation Facilities

Hard surfaced roads and railroads cross the county in all directions and provide good connections with outside markets. U. S. Highway 12 connects the towns of Bowdle, Ipswich, and Roscoe to points east and west. State Highways 45 and 47 are the main north and south roads. Hard-surfaced and graveled secondary roads feed into the main highways so that all parts of the county have easy access to shopping and market centers. Railroads provide freight service to the towns of Bowdle, Hosmer, Ipswich, Loyalton, and Roscoe and to the unincorporated communities of Craven and Mina. Airports that have limited facilities are at Bowdle and Ipswich. Passenger airline service is available at Aberdeen in neighboring Brown County.

School Facilities

Elementary and secondary schools are located at Bowdle, Hosmer, Ipswich, and Roscoe. Post-secondary education facilities are available in nearby Aberdeen and include an area vocational school, Northern State College, and Presentation College.

Manufacturing and Business Services

Grain elevators are at Bowdle, Craven, Hosmer, Ipswich, Loyalton, Mina, and Roscoe. Livestock sales barns are at Bowdle and nearby Aberdeen. A dairy processing plant is at Bowdle, and a concrete mixing plant is at Ipswich. Farm machinery and building supply outlets are at Bowdle, Hosmer, Ipswich, and Roscoe.

Trends in Soil Use

According to the 1969 U. S. Census of Agriculture, 92.6 percent of the land area in the county is farmed. In that year there were 691 farms that averaged 991 acres in size. Most farms are owner operated, and the trend is toward fewer and larger farms.

Growing wheat and producing livestock are the main farm enterprises. The principal field crops are spring wheat, oats, corn, rye, and alfalfa. Spring wheat and rye are cash crops, and oats and corn are the main feed grains. Alfalfa and alfalfa-grass mixtures are the principal tame hay crops.

In 1970 there was 73,100 acres of spring wheat, 64,000 acres of oats, 49,000 acres of alfalfa, 34,000 acres of corn, 25,000 acres of rye, and 20,000 acres planted to flax (*7*). Smaller acreages were planted to barley, durum wheat, winter wheat, sorghum, and millet. The trend during the past 30 years has been less acreage devoted to spring wheat and increasing production of feed grains, alfalfa, and other tame hay and pasture crops.

The sale of livestock, livestock products, and poultry is a major source of income to farmers in Edmunds County. Livestock numbers have steadily increased during the past 30 years. In 1970 there were 78,000 cattle on Edmunds County farms, 14,900 hogs, 7,100 sheep, and 73,600 chickens. Of the 78,000 cattle, about 4,000 were for milk production.

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Glossary

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

Association, soil. A group of soils geographically associated in a characteristic repeating pattern.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

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

California bearing ratio. The load-supporting capacity of a soil as compared to that of a standard crushed limestone, expressed as a ratio. First standardized in California, and abbreviated CBR. A soil with a CBR of 16 will support 16 percent of the load that would be supported by the standard crushed limestone, per unit area and with the same degree of distortion.

Chiseling. Tillage of soil with an implement having one or more soil penetrating points that loosen the subsoil and bring *clods* to the surface. A form of emerging tillage to control soil blowing.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

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

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

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

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

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

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

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

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

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

Conservation cropping system. Growing crops in combination with needed cultivation and management. Cropping systems include rotations that contain grasses and legumes and rotations in which the desired results are achieved without the use of such crops.

Continental climate. The climate in areas distant from the ocean; characterized by considerable variation in temperature and in other weather conditions.

Contour farming. Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.

Crop residue. A system of retaining crop residue on land between harvest and replanting to prevent erosion and insure future crop production.

Diversion, or diversion terrace. A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.

Drainage class (natural). 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 available water 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 mottling in the lower B and C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

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.

Emergency tillage. Cultivation by listing, ridging, duckfooting, chiseling, pitting, basin listing, or other means to roughen the soil surface for temporary control of soil blowing.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the assorted and unassorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by melt water as it flows from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, and covered by grass for protection against erosion; used to conduct surface water away from cropland.

Gravel. Rounded or angular rock fragments that are not prominently flattened and are up to 3 inches in diameter.

Green manure (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Horizon, soil. A layer of soil, approximately parallel to the sur-

face, 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 horizon below an A horizon. The B horizon is in part of a layer 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 an A or B horizon.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Minimum tillage. The least amount of tillage required for quick germination and a good stand. Several implements may be drawn behind the tractor to reduce the number of times it is driven over the field, but minimum tillage does not imply that primary tillage, secondary tillage, fertilization, and seeding must be done in one trip across the field.

Mottling, soil. 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.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

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; an alkaline soil is one that is alkaline in 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

Runoff (hydraulics). The part of the precipation upon a drainage area that is discharged from the area in stream channels. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium. Salinity classes of soils are based on the electrical conductivity of the saturation extract, as expressed in millimhos per centimeter at 25° C. The salinity classes and their numerical ratings of electrical conductivity are as follows:

Salinity classes	*Numerical ratings (millimhos per centimeter)*
None	Less than 2.0
Low	2.0 to 4.0
Moderate	4.0 to 8.0
High	8.0 to 16.0
Very high	More than 16.0

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be on 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 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

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.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

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 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 either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Stubble mulch. Stubble or other crop residues left on the soil, or partly worked into the soil, to provide protection from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

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

Subsoiling. Tillage of a soil below normal depth ordinarily to shatter a hardpan or claypan.

Substratum. Technically, the part of the soil below the solum.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that 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 proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam; silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

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.

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.

Wind stripcropping. Growing crops in strips that run crosswise to the general direction of prevailing wind and without strict adherence to the contour of the land.

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.

Map symbol	Mapping unit	Page	Capability unit		Pasture group		Range site		Windbreak group	
			Symbol	Page	Letter	Page	Name	Page	Number	Page
Ba	Bearden loam	9	IIe-4	34	F	42	Silty	44	1	47
Bc	Bowbells-Cresbard loams	10	IIc-3	36	--	--	---	--	--	--
	Bowbells soil	--	---	--	K	43	Overflow	44	1	47
	Cresbard soil	--	---	--	E	42	Clayey	45	4	47
BoA	Bowdle loam, 0 to 2 percent slopes	11	IIIs-2	38	D	42	Silty	44	6	48
BoB	Bowdle loam, 2 to 6 percent slopes	11	IIIe-6	37	D	42	Silty	44	6	48
BrA	Bryant loam, 0 to 2 percent slopes	12	IIc-2	35	F	42	Silty	44	3	47
BrB	Bryant loam, 2 to 6 percent slopes	12	IIe-1	34	F	42	Silty	44	3	47
BrC	Bryant loam, 6 to 9 percent slopes	12	IIIe-1	36	F	42	Silty	44	3	47
BvA	Bryant loam, sandy substratum, 1 to 3 percent slopes	12	IIIs-2	38	D	42	Silty	44	6	48
BxB	Bryant-Grassna loams, 2 to 6 percent slopes	12	IIe-1	34	--	--	Silty	44	--	--
	Bryant soil	--	---	--	F	42	---	--	3	47
	Grassna soil	--	---	--	K	43	---	--	1	47
Dv	Divide loam	13	IIIs-4	38	D	42	Silty	44	1	47
EdE	Edgeley loam, 6 to 20 percent slopes	14	VIe-1	39	F	42	Silty	44	10	49
Gr	Grassna loam	15	IIc-3	36	K	43	Overflow	44	1	47
He	Heil silt loam	16	VIs-1	40	B	42	Closed Depression	44	10	49
LeA	Lehr loam, 0 to 3 percent slopes	17	IVs-1	39	D	42	Shallow to Gravel	46	10	49
LeB	Lehr loam, 3 to 6 percent slopes	17	IVe-6	38	D	42	Shallow to Gravel	46	10	49
LhB	Lehr-Bowdle loams, 0 to 6 percent slopes	17	IVe-6	38	D	42	---	--	--	--
	Lehr soil	--	---	--	--	--	Shallow to Gravel	46	10	49
	Bowdle soil	--	---	--	--	--	Silty	44	6	48
Lt	Letcher fine sandy loam	18	IVe-13	39	H	42	Sandy	44	5	48
Lv	Loamy Fluvaquents	18	VIw-3	39	--	--	Overflow	44	10	49
Mb	Marsh	18	VIIIw-1	40	--	--	---	--	--	--
MdA	Mondamin silty clay loam, 0 to 2 percent slopes	20	IIs-1	35	I	42	Clayey	45	4	47
MdB	Mondamin silty clay loam, 2 to 6 percent slopes	20	IIIe-3	37	I	42	Clayey	45	4	47
Mh	Mondamin-Heil silty clay loams	20	---	--	--	--	---	--	--	--
	Mondamin soil	--	IIs-1	35	I	42	Clayey	45	4	47
	Heil soil	--	VIs-1	40	B	42	Thin Claypan	46	10	49
NmA	Niobell-Miranda loams, 0 to 3 percent slopes	21	---	--	--	--	---	--	--	--
	Niobell soil	--	IIIs-1	37	E	42	Clayey	45	4	47
	Miranda soil	--	VIs-1	40	--	--	Thin Claypan	46	10	49
NpB	Niobell-Noonan loams, 1 to 5 percent slopes	21	IIIe-3	37	--	--	---	--	--	--
	Niobell soil	--	---	--	E	42	Clayey	45	4	47
	Noonan soil	--	---	--	C	42	Claypan	46	9	49
Pa	Parnell silty clay loam	23	Vw-4	39	B	42	Wetland	43	10	49

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Pasture group		Range site		Windbreak group	
			Symbol	Page	Letter	Page	Name	Page	Number	Page
Rh	Ranslo-Harriet silt loams	24	VIw-4	40	--	--	---	--	--	--
	Ranslo soil	--	---	--	B	42	Subirrigated	43	2	47
	Harriet soil	--	---	--	J	42	Saline Lowland	44	10	49
Rn	Regan silt loam	25	Vw-4	39	J	42	Wetland	43	10	49
Sp	Spottswood loam	25	IIIs-2	38	D	42	Silty	44	3	47
TaB	Tally fine sandy loam, 2 to 6 percent slopes	26	IIIe-8	37	H	42	Sandy	44	5	48
TbB	Temvik-Bryant loams, 2 to 6 percent slopes	27	IIe-1	34	F	42	Silty	44	3	47
TgB	Temvik-Grassna loams, 3 to 6 percent slopes	27	IIe-1	34	--	--	Silty	44	--	--
	Temvik soil	--	---	--	F	42	---	--	3	47
	Grassna soil	--	---	--	K	43	---	--	1	47
TgC	Temvik-Grassna loams, 6 to 9 percent slopes	27	IIIe-1	36	--	--	Silty	44	--	--
	Temvik soil	--	---	--	F	42	---	--	3	47
	Grassna soil	--	---	--	K	43	---	--	1	47
Tn	Tonka-Nishon silt loams[1]	28	IIw-1[2]	34	A[2]	41	Closed Depression	44	10	49
			IVw-1[3]	39	B[3]	42				
VdC	Vida stony loam, 3 to 15 percent slopes	28	VIIs-6	40	--	--	Silty	44	10	49
VwC	Vida-Williams loams, 6 to 15 percent slopes	29	---	--	F	42	Silty	44	--	--
	Vida soil	--	VIe-3	39	--	--	---	--	10	49
	Williams soil	--	IVe-1	38	--	--	---	--	3	47
VzE	Vida-Zahill loams, 15 to 25 percent slopes	29	VIe-3	39	--	--	---	--	10	49
	Vida soil	--	---	--	F	42	Silty	44	--	--
	Zahill soil	--	---	--	G	42	Thin Upland	45	--	--
WaD	Wabek loam, 6 to 20 percent slopes	30	VIIs-4	40	--	--	Very Shallow	46	10	49
WbC	Wabek-Bowdle loams, 6 to 15 percent slopes	30	---	--	--	--	---	--	--	--
	Wabek soil	--	VIIs-4	40	--	--	Very Shallow	46	10	49
	Bowdle soil	--	IVe-5	38	D	42	Silty	44	6	48
WnB	Williams-Bowbells loams, 3 to 6 percent slopes	31	IIe-2	34	--	--	Silty	44	--	--
	Williams soil	--	---	--	F	42	---	--	3	47
	Bowbells soil	--	---	--	K	43	---	--	1	47
WnC	Williams-Bowbells loams, 6 to 9 percent slopes	31	IIIe-2	37	--	--	Silty	44	--	--
	Williams soil	--	---	--	F	42	---	--	3	47
	Bowbells soil	--	---	--	K	43	---	--	1	47
WtA	Williams-Bowbells-Nishon complex, 0 to 2 percent slopes	31	---	--	--	--	---	--	--	--
	Williams soil	--	IIc-2	35	F	42	Silty	44	3	47
	Bowbells soil	--	IIc-3	36	K	43	Overflow	44	1	47
	Nishon soil[1]	--	IIw-1[2]	34	A[2]	41	Closed Depression	44	10	49
			IVw-1[3]	39	B[3]	42				

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Pasture group		Range site		Windbreak group	
			Symbol	Page	Letter	Page	Name	Page	Number	Page
WtB	Williams-Bowbells-Nishon complex, 2 to 6 percent slopes	32	----------	--	--	--	---------	--	--	--
	Williams soil	--	IIe-2	34	F	42	Silty	44	3	47
	Bowbells soil	--	IIe-2	34	K	43	Silty	44	1	47
	Nishon soil[1/]	--	IIw-1[2/]	34	A[2/]	41	Closed Depression	44	10	49
			IVw-1[3/]	39	B[3/]	42				
WvC	Williams-Bowbells-Parnell complex, 6 to 9 percent slopes	32	----------	--	--	--	---------	--	--	--
	Williams soil	--	IIIe-2	37	F	42	Silty	44	3	47
	Bowbells soil	--	IIIe-2	37	K	43	Silty	44	1	47
	Parnell soil	--	Vw-4	39	B	42	Wetland	43	10	49

[1/] Status of artificial drainage and feasibility of drainage determined by onsite inspection.

[2/] Drained.

[3/] Undrained.

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