United States Department of Agriculture

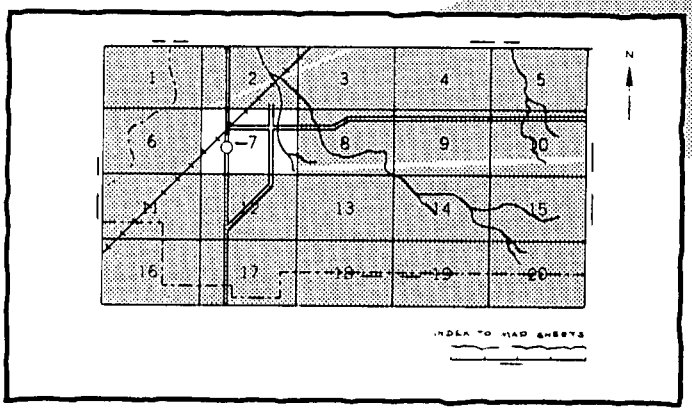
Soil Conservation Service

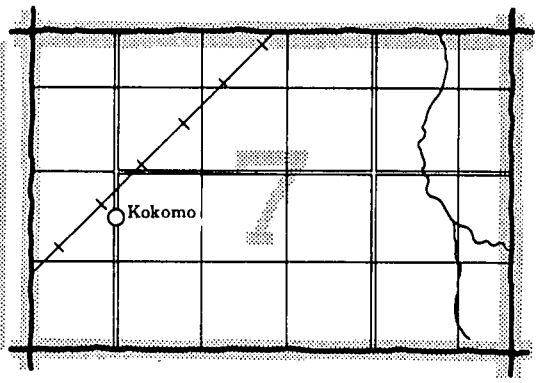
In cooperation with University of Nebraska Conservation and Survey Division

Soil Survey of Holt County, Nebraska

HOW TO USE

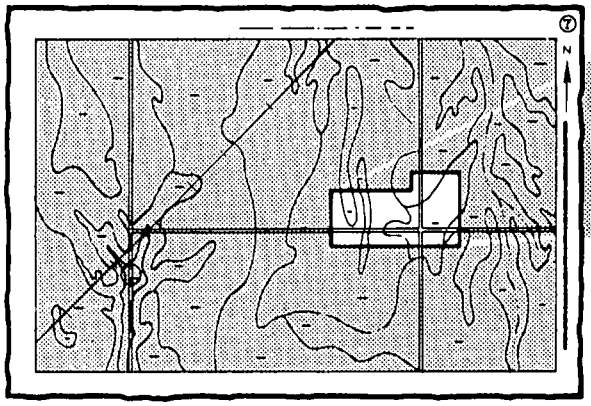
1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).

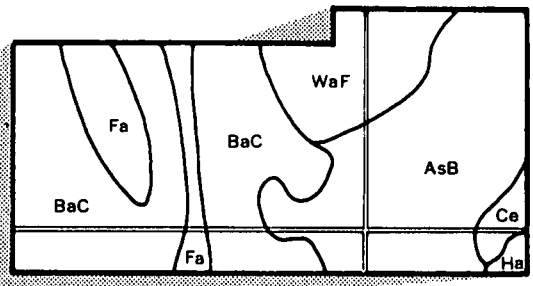




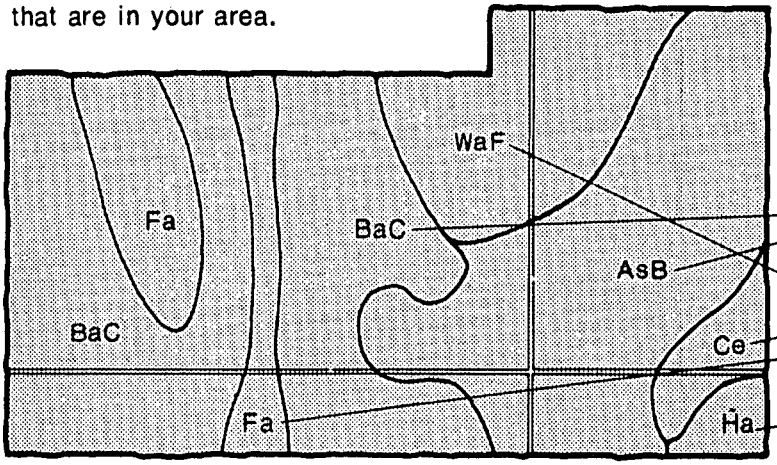
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.





4. List the map unit symbols that are in your area.

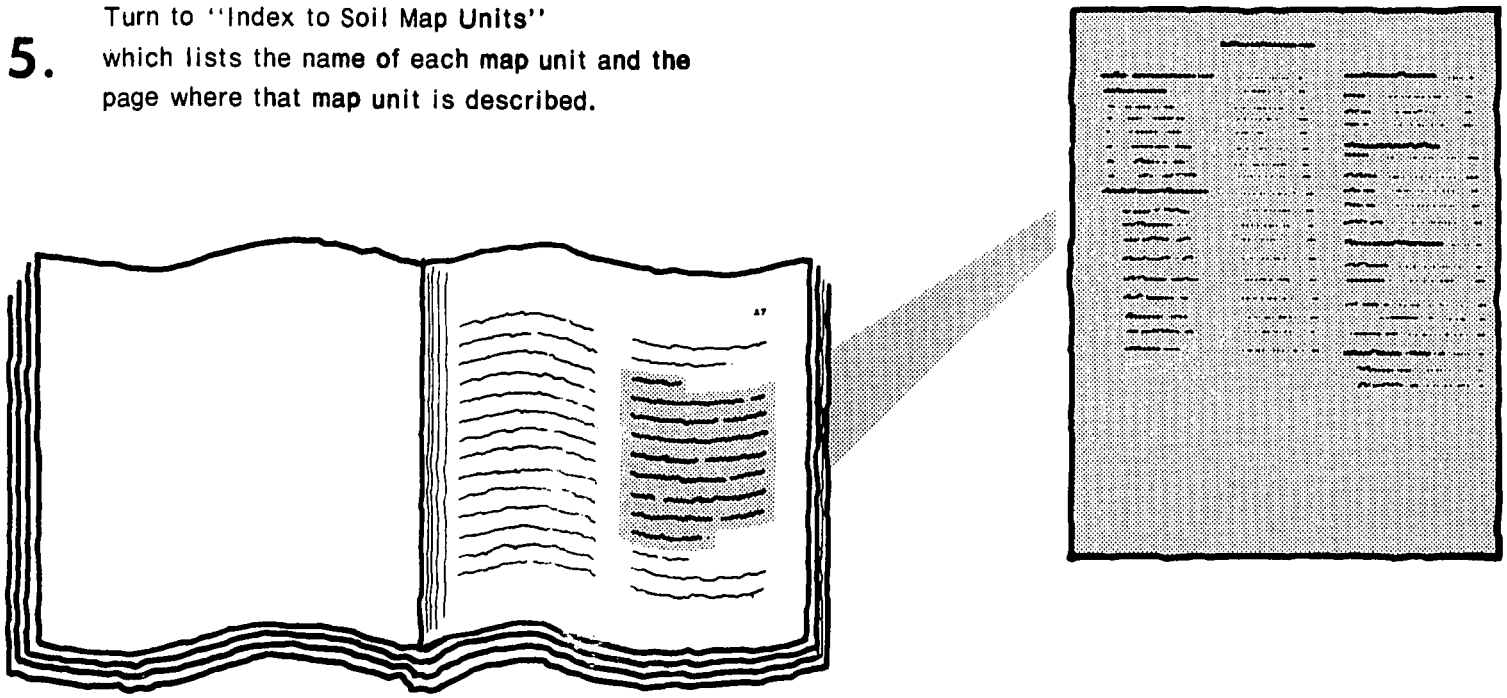


Symbols

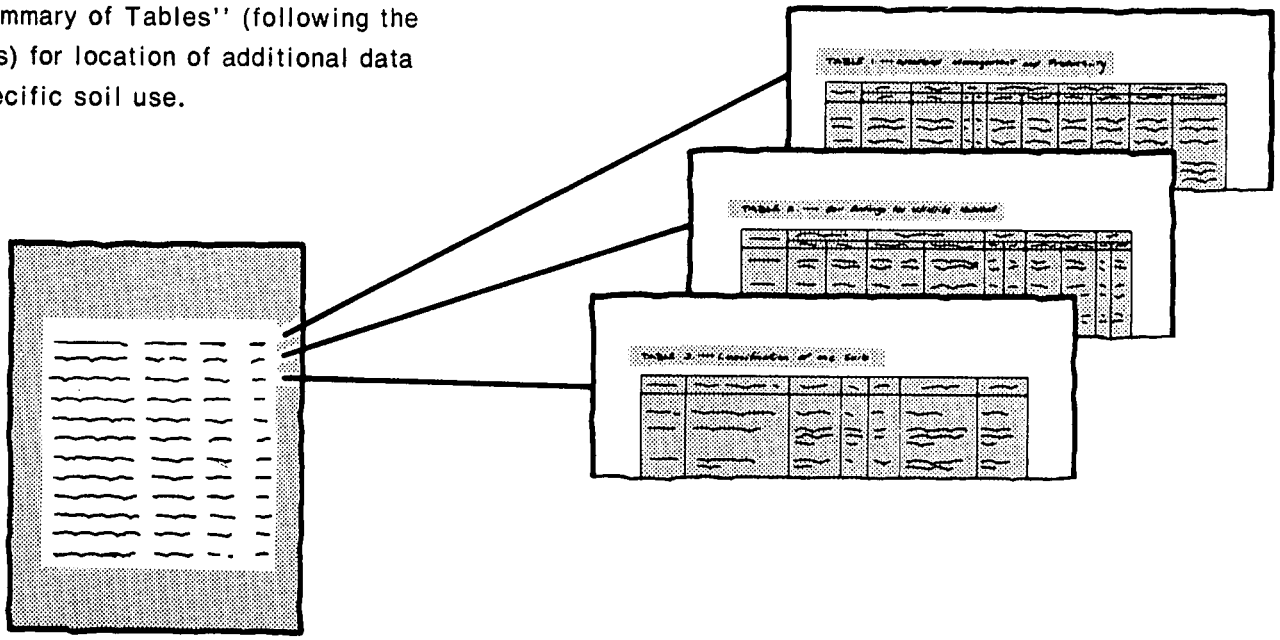
AsB
BaC
Ce
Fa
Ha
WaF

THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and state agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

This survey was made cooperatively by the Soil Conservation Service and the University of Nebraska Conservation and Survey Division. It is part of the technical assistance furnished to the Upper Elkhorn and Lower Niobrara Natural Resource Districts. The Holt County Board of Supervisors and the Old West Regional Commission provided financial assistance to purchase aerial photography and to employ a soil scientist. Major fieldwork for this soil survey was performed in the period 1973-1980. Soil names and descriptions were approved in 1981. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1981.

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

Cover: Center-pivot irrigation on soils of the Jansen-O'Neill association. Nearly 2,000 center-pivot systems have been put into operation in the county since the first one was installed about 25 years ago.

contents

Index to map units iv
Summary of tables vi
Foreword ix
General nature of the county 2
How this survey was made 5
General soil map units 7
Detailed soil map units 25
Use and management of the soils 125
Crops and pasture 125
Prime farmland 129
Rangeland 130
Native woodland 132
Windbreaks and environmental plantings 133
Recreation 134
Wildlife habitat 135
Engineering 138
Soil properties 145
Engineering index properties 145
Physical and chemical properties 146
Soil and water features 147
Physical and chemical analysis of the soils 148
Engineering index test data 148
Classification of the soils 151
Soil series and their morphology 151
Formation of the soils 183
References 187
Glossary 189
Tables 197

soil series

Anselmo series 151
Barney series 152
Bazile series 152
Boel series 153
Boelus series 153
Bristow series 154
Brunswick series 155
Cass series 156
Dunday series 156
Dunn series 157
Els series 157
Elsmere series 158
Fillmore series 159
Gannett series 160
Inavale series 160
Ipage series 160
Jansen series 161
Josburg series 162
Labu series 163
Lamo series 163
Lawet series 164
Lex series 165
Libory series 165
Loretto series 166
Loup series 166
Lute series 167
Lynch series 168
Marlake series 168
Meadin series 169
Nimbro series 169
Nora series 170
O'Neill series 171
Ord series 172
Paka series 172
Pivot series 173
Sansarc series 174
Selia series 175
Simeon series 176
Tassel series 176
Trent series 177
Tryon series 177
Valentine series 178
Verdel series 179
Wewela series 179
Whitelake series 180

Issued March 1983

index to map units

An—Anselmo fine sandy loam, 0 to 2 percent slopes 25
AnC—Anselmo fine sandy loam, 2 to 6 percent slopes 26
At—Anselmo loam, 0 to 2 percent slopes 27
Ax—Anselmo-O'Neill sandy loams, 0 to 2 percent slopes 28
AxC—Anselmo-O'Neill sandy loams, 2 to 6 percent slopes 29
Ba—Barney silt loam, channeled 29
Bb—Bazile silt loam, 0 to 2 percent slopes 30
BbC—Bazile silt loam, 2 to 6 percent slopes 31
Bg—Blownout land-Valentine complex, 6 to 60 percent slopes 32
Bm—Boel loamy fine sand, 0 to 2 percent slopes 33
Bn—Boel fine sandy loam, 0 to 2 percent slopes 34
Bo—Boel silty clay loam, overwash, 0 to 2 percent slopes 35
Bp—Boel-Inavale complex, channeled 35
BsB—Boelus loamy sand, 0 to 3 percent slopes 36
BsC—Boelus loamy sand, 3 to 6 percent slopes 37
BsD—Boelus loamy sand, 6 to 11 percent slopes 38
BtB—Boelus loamy sand, gravelly substratum, 0 to 3 percent slopes 39
BuD—Boelus-Meadin complex, 6 to 11 percent slopes 40
BwG—Bristow silty clay, 20 to 40 percent slopes 41
BxF—Brunswick-Pivot complex, 9 to 30 percent slopes 41
ByF—Brunswick-Tassel fine sandy loams, 11 to 40 percent slopes 42
Ce—Cass fine sandy loam, 0 to 2 percent slopes 42
DuB—Dunday loamy sand, 0 to 3 percent slopes 43
DuC—Dunday loamy sand, 3 to 6 percent slopes 44
DxB—Dunn loamy sand, 0 to 3 percent slopes 45
Eb—Els loamy sand, 0 to 2 percent slopes 46
EfB—Els-Ipage complex, 0 to 3 percent slopes 47
Em—Elsmere loamy fine sand, 0 to 2 percent slopes 49
En—Elsmere loamy fine sand, clayey substratum, 0 to 2 percent slopes 50
Ep—Elsmere fine sandy loam, 0 to 2 percent slopes 51
EsB—Elsmere-Ipage loamy fine sands, 0 to 3 percent slopes 52
Eu—Elsmere-Selia loamy fine sands, 0 to 2 percent slopes 54
Fm—Fillmore silt loam, 0 to 2 percent slopes 55
Gb—Gannett loam, 0 to 2 percent slopes 56
Gf—Gannett loam, wet, 0 to 2 percent slopes 57
Ia—Inavale sand, channeled 58
Ib—Inavale fine sand, 0 to 2 percent slopes 58
Id—Inavale loamy fine sand, 0 to 2 percent slopes ... 59
IfB—Ipage sand, 0 to 3 percent slopes 60
IgB—Ipage loamy sand, 0 to 3 percent slopes 60
ItB—Ipage-Tryon fine sands, 0 to 3 percent slopes ... 61
Jn—Jansen loam, 0 to 2 percent slopes 62
JnC—Jansen loam, 2 to 6 percent slopes 63
JsC—Jansen-Meadin loams, 3 to 6 percent slopes ... 64
Jt—Josburg fine sandy loam, 0 to 2 percent slopes .. 65
Jw—Josburg loam, 0 to 2 percent slopes 66
LaC—Labu silty clay, 2 to 6 percent slopes 67
LaD—Labu silty clay, 6 to 11 percent slopes 67
LcF—Labu-Sansarc silty clays, 11 to 30 percent slopes 68
Ld—Lamo-Lute loams, 0 to 2 percent slopes 70
Lf—Lawet loam, drained, 0 to 2 percent slopes 71
Lg—Lawet-Lute complex, 0 to 2 percent slopes 72
Lh—Lex-Lute loams, 0 to 2 percent slopes 74
LkB—Libory loamy fine sand, 0 to 3 percent slopes.. 75
LmB—Libory-Whitelake loamy fine sands, 0 to 3 percent slopes 76
LnC—Loretto loam, 2 to 6 percent slopes 79
Lp—Loup fine sandy loam, 0 to 2 percent slopes 79
Lr—Loup fine sandy loam, wet, 0 to 2 percent slopes 80
Ls—Loup-Inavale complex, channeled 81
LxC—Lynch silty clay, 2 to 6 percent slopes 82
LxD—Lynch silty clay, 6 to 11 percent slopes 83
Ma—Marlake fine sandy loam, 0 to 2 percent slopes 83
MeB—Meadin sandy loam, 0 to 3 percent slopes 84
MeF—Meadin sandy loam, 3 to 30 percent slopes 85
MfB—Meadin loam, 0 to 3 percent slopes 85
Nb—Nimbro silt loam, 0 to 2 percent slopes 86
No—Nora silt loam, 0 to 2 percent slopes 87
NoC—Nora silt loam, 2 to 6 percent slopes 87
OdB—O'Neill loamy sand, 0 to 3 percent slopes 88
Oe—O'Neill fine sandy loan, 0 to 2 percent slopes 89
OeC—O'Neill fine sandy loam, 2 to 6 percent slopes 90
Of—O'Neill loam, 0 to 2 percent slopes 91
OmC—O'Neill-Meadin fine sandy loams, 2 to 6 percent slopes 91
OmD—O'Neill-Meadin fine sandy loams, 6 to 11 percent slopes 92
OmF—O'Neill-Meadin fine sandy loams, 11 to 30 percent slopes 93
Or—Ord loam, 0 to 2 percent slopes 94

Os—Ord-Lute fine sandy loams, 0 to 2 percent slopes 95
Pg—Paka fine sandy loam, 0 to 2 percent slopes 97
PgC—Paka fine sandy loam, 2 to 6 percent slopes ... 98
Ph—Paka loam, 0 to 2 percent slopes 99
PhC—Paka loam, 2 to 6 percent slopes 99
PhD2—Paka loam, 6 to 11 percent slopes, eroded ... 100
Pm—Pits, sand and gravel 101
PtB—Pivot loamy sand, 0 to 3 percent slopes 101
PtC—Pivot loamy sand, 3 to 9 percent slopes 102
Rw—Riverwash 103
SaG—Sansarc silty clay, 20 to 40 percent slopes 103
SkB—Simeon sand, 0 to 3 percent slopes 104
SmB—Simeon loamy sand, 0 to 3 percent slopes 104
Te—Trent silt loam, 0 to 2 percent slopes 105
To—Tryon loamy fine sand, 0 to 2 percent slopes 106
Tp—Tryon loamy fine sand, wet, 0 to 2 percent slopes 106
Ts—Tryon-Inavale complex, channeled 107
VaB—Valentine fine sand, 0 to 3 percent slopes 109
VaD—Valentine fine sand, 3 to 9 percent slopes 109
VaE—Valentine fine sand, rolling 111
VaG—Valentine fine sand, rolling and hilly 111
VeB—Valentine-Dunday loamy fine sands, 0 to 3 percent slopes 112
VeD—Valentine-Dunday loamy fine sands, 3 to 9 percent slopes 113
VmD—Valentine-Els complex, 0 to 9 percent slopes. 115
VsD—Valentine-Simeon sands, 3 to 9 percent slopes 116
VsF2—Valentine-Simeon sands, 9 to 30 percent slopes, eroded 117
VtE—Valentine-Tryon fine sands, 0 to 17 percent slopes 118
VwD—Valentine-Wewela complex, 3 to 9 percent slopes 120
Vx—Verdel silty clay loam, 0 to 2 percent slopes 121
Ws—Wewela fine sandy loam, 0 to 2 percent slopes 122
WsC—Wewela fine sandy loam, 2 to 6 percent slopes 122
Wt—Wewela loam, 0 to 2 percent slopes 123

summary of tables

Temperature and precipitation (table 1) 198

Freeze dates in spring and fall (table 2) 199
Probability. Temperature.

Growing season (table 3) 199
Probability. Daily minimum temperature.

Acreage and proportionate extent of the soils (table 4) 200
Acres. Percent.

Yields per acre of crops and pasture (table 5) 202
Winter wheat, Corn, Alfalfa hay.

Capability classes and subclasses (table 6) 207
Total acreage. Major management concerns.

Prime farmland soils (table 7) 208

Rangeland productivity and characteristic plant communities (table 8) 209
Range site. Total production. Characteristic vegetation. Composition.

Windbreaks and environmental plantings (table 9) 222

Recreational development (table 10) 231
Camp areas. Picnic areas. Playgrounds. Paths and trails. Golf fairways.

Wildlife habitat (table 11) 240
Potential for habitat elements. Potential as habitat for—Openland wildlife, Woodland wildlife, Wetland wildlife, Rangeland wildlife.

Building site development (table 12) 246
Shallow excavations. Dwellings without basements. Dwellings with basements. Small commercial buildings. Local roads and streets. Lawns and landscaping.

Sanitary facilities (table 13) 254
Septic tank absorption fields. Sewage lagoon areas. Trench sanitary landfill. Area sanitary landfill. Daily cover for landfill.

Construction materials (table 14) 263
Roadfill. Sand. Gravel. Topsoil.

Water management (table 15) 270
Limitations for—Pond reservoir areas; Embankments, dikes, and levees. Features affecting—Drainage, Irrigation, Terraces and diversions, Grassed waterways.

Engineering index properties (table 16) 278
Depth. USDA texture. Classification—Unified, AASHTO. Fragments greater than 3 inches. Percentage passing sieve—4, 10, 40, 200. Liquid limit. Plasticity index.

Physical and chemical properties of soils (table 17) 290
Depth. Clay. Moist bulk density. Permeability. Available water capacity. Soil reaction. Salinity. Shrink-swell potential. Erosion factors. Wind erodibility group. Organic matter.

Soil and water features (table 18) 297
Hydrologic group. Flooding. High water table. Bedrock. Potential frost action. Risk of corrosion.

Engineering index test data (table 19) 303
Classification. Grain size distribution. Liquid limit. Plasticity index. Moisture density.

Classification of the soils (table 20) 307
Family or higher taxonomic class.

foreword

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

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

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

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

Albert E. Sullivan
State Conservationist
Soil Conservation Service

soil survey of
Holt County, Nebraska

by Larry G. Ragon, Vernon C. Seevers, and Orville Indra
Soil Conservation Service
and Francis V. Belohlavy, Stephen J. Lobaugh, Jan Carlson,
and Harvey Schultz
University of Nebraska Conservation and Survey Division

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

HOLT COUNTY is in north-central Nebraska on the eastern edge of the Nebraska Sandhills region (fig. 1). It is 48 miles wide and about 56 miles long at its longest point. The irregular northern boundary is formed by the deeply entrenched Niobrara River. Holt County is bordered on the north by Boyd County, on the west by Rock County, on the south by Garfield and Wheeler Counties, and on the east by Antelope and Knox Counties. The county has an area of about 2,405 square miles, or 1,539,264 acres. O'Neill is the largest town and the county seat. Other towns in the county are Atkinson, Chambers, Stuart, Ewing, Inman, Page, Emmett, and Amelia.

The general economy of the county is based primarily on cattle ranching, hay production, and irrigated corn.

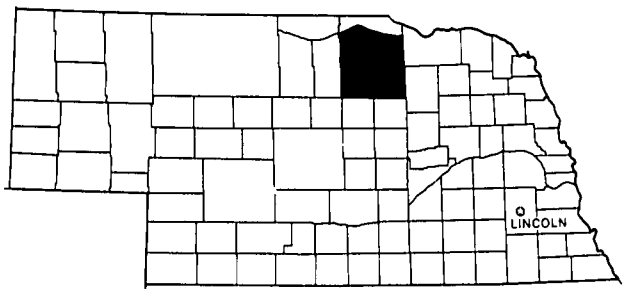


Figure 1.—The location of Holt County in Nebraska.

However, other commerce and industry are important to the local economy. Most employment in the county is in farming and ranching or other related businesses.

About 75 percent of the county is rangeland and about 20 percent is cropland. Since inadequate seasonal rainfall restricts the growth of crops in most years, most of the cropland is irrigated. Some of the dryfarmed areas lack a suitable source of ground water for irrigation.

The soils range widely in texture, drainage, and other characteristics. Soils south of the Elkhorn River are mostly sandy. They formed in eolian and alluvial sand or a mixture of both. This part of the county is characterized by rolling and hilly sandhills and broad flat valleys that have a high water table. Ranching and hay production are the main agricultural enterprises. However, irrigated cropland has recently been developed in this area. Wetness, caused by the seasonal high water table, and soil blowing are the principal concerns of management if these soils are farmed.

North of the Elkhorn River the soils are sandy, loamy, or clayey. They are deep over windblown and alluvial material and shallow to deep over gravelly sand, weathered sandstone, or shale. The soils are excessively drained to very poorly drained. Slopes range from nearly level to very steep. The majority of the irrigated corn produced in the county is grown on soils north of the Elkhorn River. Soil blowing and water erosion are the principal hazards. Conserving soil moisture and

controlling erosion are the main concerns of management. Maintaining soil fertility and water management are the principal concerns under irrigation.

The first soil survey of Holt County was published in 1938 (*6*). The present survey updates the first survey and gives additional information. It has large maps that show the soils in greater detail.

general nature of the county

This section provides general information about Holt County. It discusses history and development; climate; geology and ground water resources; physiography, drainage, and relief; and trends in farming and soil use.

history and development

The first European explorer to reach Holt County was probably Jacques M. Mackey, a Scotsman who explored the Nebraska Sandhills in 1795 and 1796. The first settler in Holt County was William Inman, who arrived before 1871. General John J. O'Neill led an Irish colony from Michigan and Pennsylvania to Holt County in May 1874. From 1875 through 1877 General O'Neill brought more families to the growing colony. That settlement became what is now the city of O'Neill.

The county was officially organized by election in 1876. Holt County was named in honor of Joseph Holt of Kentucky, who was Postmaster General and Secretary of War under President Buchanan. The county seat, originally at Paddock, was moved to O'Neill in 1879. Early settlers to the county came from the eastern United States, Germany, Canada, Austria, Ireland, and Czechoslovakia (*14*).

According to the 1980 census, the county population was 13,523. O'Neill, the largest town in Holt County, had a population of 4,007. The county population has declined since 1940, but the town of O'Neill has had a population increase over the same period. Most of the population is located north of the Elkhorn River. The area south of the Elkhorn River is more sparsely populated.

O'Neill is near the central part of the county along the Elkhorn River. Ewing, Inman, Emmett, Atkinson, and Stuart are other towns located along the Elkhorn River. Page is in the eastern part of the county, north of the Elkhorn River. Chambers and Amelia are in the south-central part of the county. These towns provide distribution centers and local markets for the products of the area.

The first railroad to reach Holt County was the Fremont, Elkhorn, and Missouri Valley Railroad in 1882. The Sioux City and Pacific Railroad reached O'Neill in 1890. Currently, one railroad in the county follows the Elkhorn River east and west across the county and another is in the east-central part of the county and serves Page and O'Neill, where it ends.

State and federal, hard surfaced roads serve all of the towns in Holt County. U.S. 20 runs east-west through the county. U.S. 275 follows the Elkhorn River through Ewing to O'Neill. U.S. 281 runs north-south through O'Neill, and NB-11 runs north-south through Atkinson. NB-95 connects U.S. 281 with NB-11 and runs through Chambers. Many hard surfaced, gravel, and improved dirt county roads serve various parts of the county. Trails provide access to the more remote areas. Most of the roads are on section lines, except in the sandhill areas of the county. Rural mail routes reach all parts of the county. Telephones and rural electrification serve all rural areas. Natural gas is available in rural areas. A bus line and limited air service are also available.

Elementary schools and high schools are in O'Neill, Ewing, Chambers, Atkinson, and Stuart. Rural school districts and elementary schools also serve the county.

Several agribusinesses in the county sell fertilizer and process feed for livestock. Many sell and service farm machinery.

climate

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

In Holt County, winters are cold because of incursions of cold, continental air that bring frequent spells of low temperature. Summers are hot with occasional interruptions of cooler air from the north. Snowfall is relatively frequent in winter, but snow cover is usually not continuous. Rainfall is heaviest late in spring and early in summer. Annual precipitation is normally adequate for wheat, sorghum, and range grasses.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Atkinson, Nebraska in the period 1951 to 1973. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 24 degrees F, and the average daily minimum temperature is 13 degrees. The lowest temperature on record, which occurred at Atkinson on January 29, 1966, is -27 degrees. In summer the average temperature is 72 degrees, and the average daily maximum temperature is 84 degrees. The highest recorded temperature, which occurred on July 11, 1954, is 106 degrees.

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

The total annual precipitation is 21.7 inches. Of this, 17 inches, or 80 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through

September is less than 14 inches. The heaviest 1-day rainfall during the period of record was 3.95 inches at Atkinson on August 12, 1966. Thunderstorms occur on about 50 days each year, and most occur in summer.

Average seasonal snowfall is 31 inches. The greatest snow depth at any one time during the period of record was 20 inches. On an average of 19 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 75 percent of the time possible in summer and 60 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 12 miles per hour, in spring.

Severe duststorms occur occasionally in spring when strong dry winds blow over unprotected soils. Tornadoes and severe thunderstorms, some with hail, occur occasionally. These storms are local and of short duration. The pattern of damage is variable and spotty.

geology and ground water resources

The bedrock in Holt County is Cretaceous age Pierre Shale and interbedded silt, sand, sandstone, and siltstone of the Tertiary age Ogallala Formation. Ogallala is the bedrock throughout most of the county, except in the extreme northern part where it has been removed by erosion. Ogallala sediment is exposed at the surface at some locations along the north side of the Elkhorn River and along the upper reaches of the drainage tributary to the Niobrara River. Although the Ogallala is considered bedrock, it often is unconsolidated or only slightly consolidated (fig. 2). The Pierre Shale forms the bedrock in the northern part of the county where the Ogallala sediment has been removed. This area includes the Niobrara River Valley, the lower reaches of its tributary valleys, and some of the upland area between the valleys. The Pierre Shale is at the surface in places in the uplands and along the valleys, primarily along Eagle and Redbird Creeks and on the Niobrara River valley side.

Unconsolidated sediment of Quaternary age overlies the bedrock throughout the county. The sediment consists of water-deposited sand, gravel, silt, and clay and wind-deposited sand and silt. In places where the

Figure 2.—A roadside exposure showing the shallow Tassel soils that formed in sandstone of the Ogallala Formation.

bedrock is exposed, Quaternary sediment is absent. South of the Elkhorn River, the unconsolidated material at the surface is mostly windblown sand, which is underlain by water-deposited sand and gravel and interbedded silt and clay. North of the Elkhorn River, the unconsolidated materials are loamy material mixed with coarse sand and gravel and some areas of windblown sand.

The sources of ground water for domestic, municipal, and irrigation wells in Holt County are the Quaternary sands and gravels and the coarser textured sediment of the Ogallala Formation. This sediment provides an abundant supply of ground water throughout most of the county. Because the Ogallala Formation is in hydraulic connection with the Quaternary sediments, these two units are considered to be a single aquifer or ground water reservoir.

South of the Elkhorn River, the sediment ranges in thickness from more than 300 feet near the river to more than 700 feet in the southwestern corner of the county. The Quaternary sediment is generally coarser textured than the underlying Ogallala sediment and, thus, will yield water to wells at a greater rate. The Ogallala Formation, however, does contain some coarse sand and gravel. In most places, high-yielding wells are obtained by penetrating only the Quaternary sediment. Where this sediment is thin or fine textured, some wells also penetrate the Ogallala sediment. Most of the high capacity wells do not penetrate the entire thickness of the aquifer.

North of the Elkhorn River, the Quaternary and Ogallala sediments thin northward. It is still possible to obtain high-yielding wells by penetrating only a small interval of the coarse-textured Quaternary sediment; however, many wells do penetrate the entire thickness of the aquifer (*5*). As the sediments thin out to the north it becomes more difficult to obtain high-yielding wells. Where the Pierre Shale is exposed or near the surface, it is difficult to obtain even a low-yielding well suitable for domestic and livestock use.

The quality of water derived from the Quaternary and Ogallala sediments generally is quite good, with low dissolved solid content. This is because the sandy soil contains little organic matter, and the subsoil and water saturated sediments contain little readily soluble material. In places, the water has been contaminated by applied agricultural chemicals and disposal of human, livestock, and household wastes. The sandy texture of the soils and the shallow water tables result in the aquifer being susceptible to contamination from sources at the land surface.

One possible source of water in the northern part of the county, in areas where the younger sediments are not present, is the Cretaceous-age Dakota Formation. Although the potential for high-yielding wells in the Dakota Formation is possible, well depths would be between 1,000 and 2,000 feet. The high cost of drilling wells so deep and the cost of energy required for the potential large pumping lifts are important factors affecting the use of the Dakota Formation for water supplies. Another concern is the quality of water. The water generally is hard and high in sulfates and often high in iron and manganese. Water from the Dakota Formation, however, has been used for irrigation and domestic supplies in areas north and east of Holt County.

Large withdrawals of water for irrigation have caused water levels to decline in some areas north of the Elkhorn River. Future water level changes will depend on the amount of withdrawals and the response of the aquifer to these withdrawals.

physiography, drainage, and relief

Holt County is in the Great Plains physiographic province. The topography consists of four general landforms—Niobrara Valley, Holt Table, subirrigated valleys, and sandhills.

The Niobrara Valley occupies the extreme northern part of Holt County. It includes the dissected uplands along the Niobrara River and its tributaries. Slopes range from nearly level to very steep. This area includes high stream terraces that extend east-west across the northern part of the county along the Niobrara River. The terraces are nearly level to gently sloping. They range from 3 to 5 miles in width and are 100 to 200 feet above the level of the Niobrara River. Alluvial sand and gravel is deposited in variable thickness over the bedrock. In places, the streams have cut through the alluvial sands and gravel, and Ogallala bedrock or Pierre Shale is at the surface on the side slopes. In places, the sands have been reworked by the wind into a low hummocky or dune topography.

The Holt Table is the highest geological upland position in Holt County. It is about 200 feet higher than the stream terraces in the Niobrara Valley to the north and 20 to 150 feet higher than the subirrigated valleys along the Elkhorn River to the south. The Holt Table extends east-west across the county and ranges from 5 to 10 miles in width. Most of the Holt Table is a nearly level to very gently sloping plain modified in places by low sandhills and narrow stream valleys. The northern edge of the Holt Table has strongly sloping to steep topography and is dissected by drainageways. Most of the drainage in this area is to the Niobrara River. The southern part of the Holt Table is along the Elkhorn River.

The subirrigated valleys and sandhills are south of the Holt Table. The subirrigated valleys are broad, nearly level to very gently sloping bottom lands along the Elkhorn River and its tributaries. The high water table in this area permits the growth of luxuriant stands of native grasses. The valleys merge through transitional areas of low rolling and hummocky topography with the rolling and hilly sandhills. The largest sandhills are mostly in the

southwestern part of the county. The sandhills rise 10 to 200 feet or more above the intervening valleys and swales. Small lakes and wet areas are in some of the valleys and swales. Blowouts are common throughout the sandhill areas.

The Elkhorn River flows in a southeasterly direction across the county, dividing the county into two almost equal parts. Runoff in the southern part of the county is to the Elkhorn River. The perennial flowing streams are small, slow moving, and entrenched to a depth of about 4 or 5 feet. Streamflow during dry periods is maintained by seepage of ground water into the stream channels. Most of the creeks flow throughout the year. Artesian wells are located mostly in this part of the county. Drainage patterns in the sandhills are not well defined. Most rainfall infiltrates the sandy soil, and there is little runoff. Tributaries of the Elkhorn River are Cache, Clearwater, Dry, Holt, and Keegan Creeks and the South Fork of the Elkhorn River.

Runoff in the northern part of the county is mostly north and east into tributaries of the Niobrara River. Flows of the tributaries are maintained by ground water seepage from the aquifers underlying the Holt Table. Seepage occurs as numerous springs on lower side slopes and in the bottom of drainageways. Bottom lands along the Niobrara River tributaries are usually narrow and are subject to flooding following locally heavy rains. Tributaries of the Niobrara River include Otter, Clay, Beaver, Big Sandy, Little Sandy, Brush, Spring, Turkey, Eagle, Camp, Honey, Blackbird, Redbird, Louse, Sandy, Squaw, Steele, North Branch Verdigre, Middle Branch Verdigre, and South Branch Verdigre Creeks.

Elevation along the Elkhorn River bottom lands ranges from 2,150 feet south of Stuart to 1,850 feet south of Ewing. Elevation on the Holt Table ranges from 2,175 feet east of Stuart to 2,000 feet southeast of Page. Average elevation is 2,155 feet at Stuart, 2,110 feet at Atkinson, 1,988 feet at O'Neill, 1,956 feet at Page, 1,855 feet at Ewing, 1,930 feet at Inman, and 2,110 feet at Chambers.

trends in farming and soil use

Ranching and farming have been the most important enterprises in Holt County since its settlement. Livestock ranching is the main agricultural enterprise, and corn production is second. Nearly 20 percent of the county is cropland; about three-fourths of the cropland is irrigated. Water for irrigation is mostly from wells and is delivered by center-pivot irrigation systems. Small grains and alfalfa are the principal dryfarmed crops. Corn is the main irrigated crop. About 75 percent of the county is in native grass that is used for grazing or cut for hay. About 2 percent of the county is native woodland.

According to the Nebraska Agricultural Statistics reports, the number of ranch operating units and farms in the county decreased from 1,430 in 1969 to 1,280 in 1979. Most of the operating units are ranches for raising livestock, mainly cow-calf herds. Nearly all of the ranches have an acreage of native grass that is cut for hay and used as winter livestock feed. Most of the farms in the county combine dryland and irrigated farming with ranching or cattle operations.

Raising cattle and selling calves in the fall as feeders is one of the largest industries in the county. A few ranches produce purebred cattle. Some sheep and lambs are raised, and most of the lambs are sold as feeders. Hogs are raised on some farms and are fattened in feedlots or sold as feeder pigs. A few farmers have small dairy herds. Most of the milk is marketed locally. Chickens are raised for family use on many farms. Livestock in the county, according to the 1978 Nebraska Agricultural Statistics report, consists of about 219,500 beef cattle and calves, 75,400 hogs and pigs, 6,000 milk cows, 3,000 sheep and lambs, and 15,800 chickens. Livestock numbers fluctuate from year to year, but the average remains fairly constant.

Since the introduction of center-pivot irrigation in the 1950's, corn grown as a cash crop has become important to the economy of Holt County. The increased emphasis on irrigation has caused increased use of commercial fertilizers and greater use of water for irrigation. According to the Nebraska Department of Water Resources, water from 583 wells irrigated about 79,000 acres in 1969. By January 1980, water from 1,953 wells was being used to irrigate about 250,000 acres of cropland.

According to Nebraska Agricultural Statistics reports, the acreage of irrigated corn harvested for grain increased from 48,000 acres in 1969 to 174,000 acres in 1978. Dryland corn acreage decreased from 33,780 acres in 1969 to 7,100 acres in 1978. In 1978 there were 42,600 acres of dryland alfalfa, 6,400 acres of irrigated alfalfa, 19,300 acres of wheat and other small grains, and 1,900 acres of soybeans. The acreage of irrigated alfalfa and the acreage of soybeans have increased slightly since 1969. Several thousand acres of popcorn are grown in Holt County each year. A few acres of sunflowers for commercial use have been planted in recent years.

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study 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, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with

others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, rangeland managers, engineers, planners, developers and builders, home buyers, and others.

general soil map units

The general soil map at the back of this publication shows broad areas, called soil associations, that have a distinctive pattern of soils, relief, and drainage. Each soil association on the general soil map is a unique natural landscape. Typically, each association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in other associations but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

nearly level to very steep soils in the sandhills

Two associations are in this group. The soils are deep, excessively drained, moderately well drained, and somewhat poorly drained, sandy soils. They formed in windblown and alluvial material. Areas of this group are used mostly for rangeland. A small part is used for cropland that is irrigated by center-pivot sprinkler systems from deep wells. Soil blowing is a hazard if the grass cover is destroyed. Wetness is a problem in low areas in the spring and during periods of above normal rainfall. Maintaining a high level of fertility, conserving moisture, and improving the condition of the rangeland are other concerns of management.

1. Els-Valentine-Ipage association

Deep, nearly level to strongly sloping, excessively drained, moderately well drained, and somewhat poorly drained, sandy soils; on uplands and in sandhill valleys

This association consists of areas of hummocky sandhills and the intervening valleys and swales. Slopes range mostly from 0 to 9 percent. The soils formed in windblown sand or in sandy alluvium that has been reworked by wind (fig. 3).

This association occupies 320,382 acres, or about 21 percent of the county. It is about 34 percent Els soils, 31 percent Valentine soils, 14 percent Ipage soils, and 21 percent soils of minor extent.

The Els soils are nearly level and on the bottom of valleys. They are somewhat poorly drained. The seasonal high water table ranges from a depth of about 1.5 feet in wet years to about 2.5 feet in dry years. Typically, the surface layer is dark gray, very friable loamy sand about 6 inches thick. The transitional layer is grayish brown, loose fine sand about 7 inches thick. The underlying material extends to a depth of more than 60 inches. It is mottled brown, very pale brown, and white sand in the upper part and white coarse sand in the lower part.

The Valentine soils are gently sloping to strongly sloping and are on dunes. They are excessively drained. Typically, the surface layer is grayish brown, loose fine sand about 5 inches thick. The transitional layer is light brownish gray, loose fine sand about 5 inches thick. The underlying material is pale brown fine sand to a depth of more than 60 inches.

The Ipage soils are nearly level to very gently sloping and are on low ridges in sandhill valleys. They are moderately well drained. The seasonal high water table ranges from a depth of about 3 feet in wet years to about 6 feet in dry years. Typically, the surface layer is dark grayish brown, very friable sand about 5 inches thick. The transitional layer is grayish brown, loose sand about 6 inches thick. The underlying material extends to a depth of 60 inches or more. It is pale brown sand in the upper part, very pale brown and white fine sand in the middle part, and light gray coarse sand in the lower part.

Of minor extent in this association are Elsmere, Libory, Loup, Tryon, and Marlake soils. Elsmere soils are in similar positions as the Els soils and are dark to a depth of 10 inches or more. Libory soils are on stream terraces and have loamy underlying material. Loup and Tryon soils are lower on the landscape than Els soils and have a higher seasonal water table. Marlake soils are in the lowest positions on the landscape and are covered by water much of the time. A few areas of steep sandhills are in this association, but over most of the association the dunes are less than 15 feet high. Blowouts are common throughout this association.

Most areas of this association are in native grass that is used as rangeland or harvested for hay. Farms and ranches in this association are diversified, mainly a combination of livestock and cash grain enterprises. Some of the nearly level soils on bottom lands and in sandhill valleys are dryfarmed, but most of the cropland

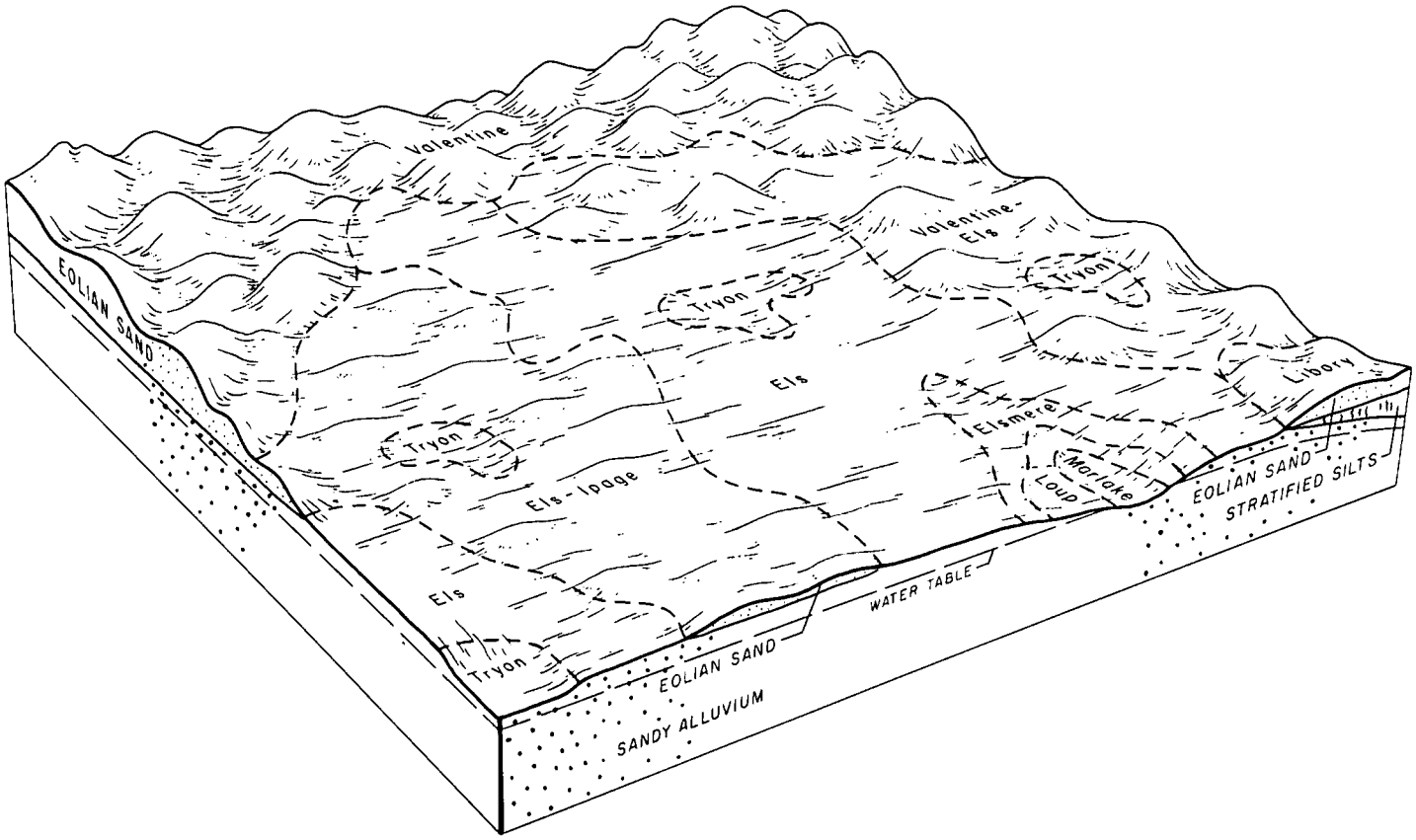


Figure 3.—Typical pattern of soils in the Els-Valentine-Ipage association and their relationship to topography and parent material.

in this association is irrigated. A large part of the soils are too hummocky and sandy for cultivated crops under dryland farming. The soils are suited or poorly suited to irrigation. Corn and alfalfa are the main crops under both dryland and irrigation management. Wells produce water of good quality for livestock and irrigation uses.

Range management that includes proper grazing use, timely deferments from grazing or haying, and a system of use and rest with the order changed each year helps to maintain or improve the range condition. Proper distribution of livestock can be achieved by proper placement of fences, salt, and water facilities. Soil blowing is a hazard if the protective grass cover is destroyed. Wetness can be a problem in cultivated areas of Els soils and in areas of the included Loup and Tryon soils. The water table benefits grasses and cultivated crops during dry periods, but it can cause severe wetness problems in periods of above normal rainfall. Increasing the organic matter content and improving fertility are concerns of management. Maintaining crop residue on the surface, stripcropping, and minimum tillage help to control soil blowing and conserve soil moisture. Irrigation water management is also a concern of management. If the soils are overgrazed, severe losses by soil blowing occur, and small blowouts can develop.

2. Valentine-Els association

Deep, nearly level to very steep, excessively drained and somewhat poorly drained, sandy soils; on uplands and in sandhill valleys

This association consists of steep, hummocky sandhills and intervening valleys and swales (fig. 4). Slopes range from 0 to more than 30 percent. Many of the dunes rise as much as 200 feet above the valley. The soils in the association formed in windblown sand and alluvium.

This association occupies 264,586 acres, or about 17 percent of the county. It is about 73 percent Valentine soils, 16 percent Els soils, and 11 percent soils of minor extent.

The Valentine soils are gently sloping to very steep and are on hummocky and dune-like uplands. They are

excessively drained. Typically, the surface layer is grayish brown, loose fine sand about 5 inches thick. The transitional layer is light brownish gray, loose fine sand about 4 inches thick. The underlying material is pale brown fine sand to a depth of more than 60 inches.

The Els soils are nearly level and are on the bottom of valleys in the sandhills. They are somewhat poorly drained. The seasonal high water table ranges from a depth of about 1.5 feet in wet years to about 2.5 feet in dry years. Typically, the surface layer is dark gray, very friable loamy sand about 6 inches thick. The transitional layer is grayish brown, loose fine sand about 7 inches thick. The underlying material extends to a depth of more than 60 inches. It is mottled brown, very pale brown, and white sand in the upper part and white coarse sand in the lower part.

Of minor extent in this association are Ipage, Marlake, and Tryon soils. Ipage soils are on higher bottom land positions than Els soils and are moderately well drained. Tryon and Marlake soils are lower on the landscape. Tryon soils are poorly drained and very poorly drained. Marlake soils are in the lowest positions and are covered by water much of the time. Blowouts are common in areas of the Valentine soils.

Most areas of this association are in native grass and are used for grazing. Only a few areas are used for hay, because the valleys are too narrow for more than an occasional small meadow. Farms and ranches in this association are mainly livestock enterprises engaging in cow-calf operations. Most of this association is unsuited to cultivated crops because of steepness of the slopes. In a few areas, the more gently sloping soils are used as irrigated cropland. Corn and alfalfa are the irrigated crops. Wells provide good quality water for livestock and irrigation uses.

Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. Overgrazing can also cause severe losses through soil blowing, creating small blowouts. Proper grazing use, timely deferments from grazing, and a system of use and rest with the order changed each year help to maintain or improve the range condition. Proper distribution of

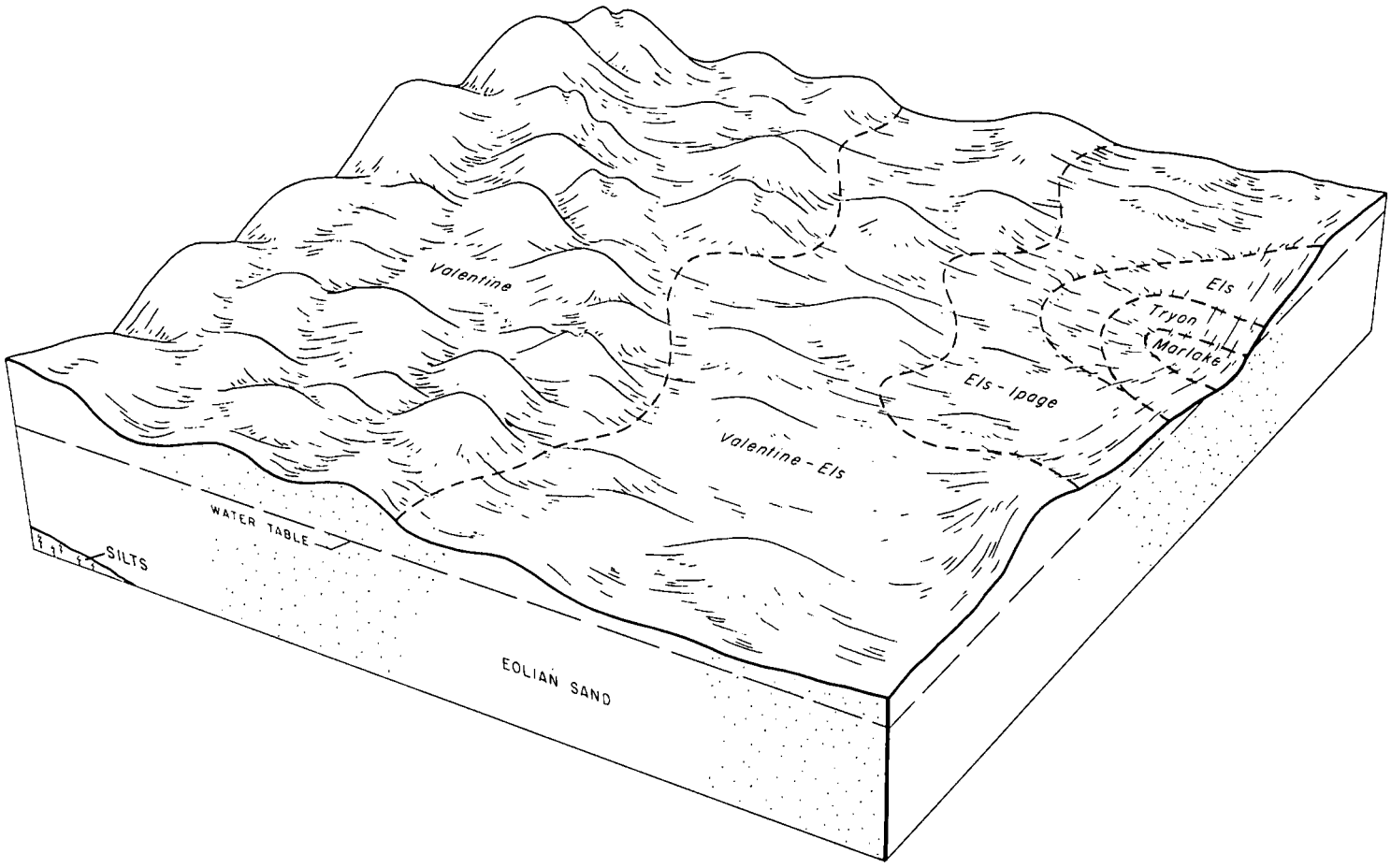


Figure 4.—Typical pattern of soils in the Valentine-Els association and their relationship to topography and parent material.

livestock can be achieved by proper placement of fences, salt, and water facilities. In cultivated areas, soil blowing is the main management problem. Keeping crop residue on the surface and using minimum tillage help to control soil blowing and conserve soil moisture on the Valentine soils. Wetness is a problem on the Els soils. Increasing the organic matter content and improving fertility are also concerns in the management of cropland.

nearly level and very gently sloping soils on bottom lands, on stream terraces, and in sandhill valleys

There are three associations in this group. The soils are deep, or they are moderately deep and shallow over coarse sand. They are somewhat excessively drained to very poorly drained, loamy and sandy soils that formed in windblown and alluvial material. Most areas of the sandy soils are used for rangeland. Areas of the loamy soils are used more extensively for cropland. Most of the cropland is irrigated by center-pivot sprinkler systems from deep wells. Soil blowing and wetness because of the high water table are the main hazards. Alkali is a problem in some places. Conserving soil moisture, maintaining a high level of fertility, and improving the condition of the rangeland are other concerns of management.

3. Elsmere-Ipage-Loup association

Deep, nearly level and very gently sloping, moderately well drained to very poorly drained, sandy and loamy soils; on bottom lands, on stream terraces, and in sandhill valleys

This association is on broad, flat valleys along major streams and in valleys of the sandhills (fig. 5). Slopes range from 0 to 3 percent. These soils formed in windblown and alluvial sands.

This association occupies 290,304 acres, or about 19 percent of the county. It is about 43 percent Elsmere soils, 20 percent Ipage soils, 16 percent Loup soils, and 21 percent soils of minor extent.

The Elsmere soils are nearly level and on bottom lands. They are somewhat poorly drained. A seasonal high water table ranges from a depth of about 1.5 feet in wet years to about 2.5 feet in dry years. Typically, the surface layer is dark grayish brown, very friable loamy

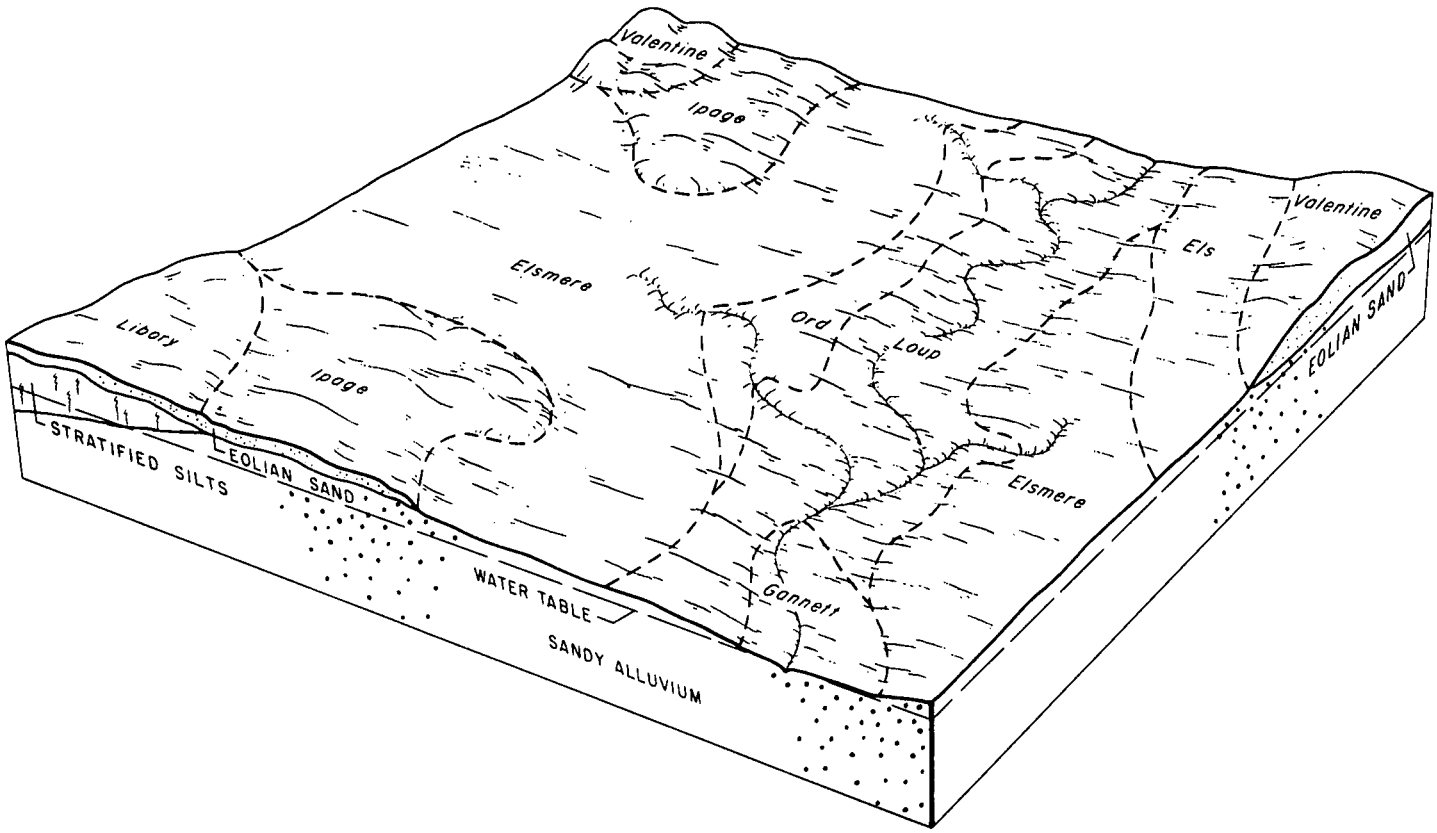


Figure 5.—Typical pattern of soils in the Elsmere-Ipage-Loup association and their relationship to topography and parent material.

fine sand about 4 inches thick. The subsurface layer is about 14 inches thick. It is dark gray, very friable loamy fine sand in the upper part and dark grayish brown, very friable fine sand in the lower part. The transitional layer is brown, loose fine sand about 6 inches thick. The underlying material is fine sand to a depth of more than 60 inches. It is very pale brown in the upper part, gray in the middle part, and light gray in the lower part. It has grayish brown and yellowish brown mottles.

The Ipage soils are nearly level and very gently sloping and on low ridges in valleys and on stream terraces. They are moderately well drained. A seasonal high water table ranges from a depth of about 3 feet in wet years to about 6 feet in dry years. Typically, the surface layer is dark grayish brown, very friable loamy sand about 7 inches thick. The transitional layer is brown, loose fine sand about 5 inches thick. The underlying material is very pale brown fine sand to a depth of more than 60 inches.

The Loup soils are nearly level and on bottom lands. They are poorly drained or very poorly drained. A seasonal high water table ranges from 0.5 foot above the surface in wet years to a depth of about 1.5 feet below the surface in dry years. Typically, the surface layer is very dark gray, very friable, calcareous fine sandy loam about 6 inches thick. The subsurface layer is dark gray, very friable fine sandy loam about 4 inches thick. The transitional layer is mottled, gray, loose fine sand about 4 inches thick. The mottled underlying material extends to a depth of about 60 inches. It is light gray and grayish brown fine sand in the upper part and dark gray fine sandy loam in the lower part.

Of minor extent in this association are Dunday, Gannett, Libory, Lute, Ord, and Valentine soils. Dunday, Libory, and Valentine soils are higher on the landscape. Dunday and Valentine soils are sandy and better drained. Libory soils have loamy underlying material. Gannett soils are in similar positions as Loup soils and have finer textures. Lute and Ord soils are in similar positions as Elsmere soils. Lute soils are high in sodium content. Ord soils have finer textures.

A large part of this association is in native grass that is used as hayland or rangeland. The most extensive areas of hayland are in this association. Most of this association is suited to cropland, but only about 10 percent is used for cultivated crops. Most of the cropland is irrigated by center-pivot sprinkler systems. Alfalfa and corn are the main dryland and irrigated crops. Only a small acreage of introduced grasses is irrigated.

Overgrazing, improper timing of mowing, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Range management that includes proper grazing use, timely deferments from grazing or haying, and restricted use during very wet periods helps to maintain or improve the range condition. Wetness, caused by the high water table, and soil blowing are the main management problems if these areas are farmed. Alkalinity is a severe limitation in places. The seasonal high water table benefits grasses and cultivated crops during dry seasons, but it interferes with haying and tillage operations during wet seasons. Artificial drainage, such as tile drains or open drainage ditches, are needed before some areas can be irrigated. Normally, the Elsmere soils can be farmed without installing tile drains or drainage ditches, but the water table can be a problem in years of above normal rainfall. Loup soils are too wet for use as cropland. Soil blowing can be controlled by keeping the soil covered with crops or crop residue. Maintaining fertility and managing irrigation water are concerns of management.

4. Lex-Cass-Lute association

Nearly level, well drained and somewhat poorly drained, loamy soils that are deep and moderately deep over sand; on bottom lands

This association consists of soils on bottom lands along the Elkhorn River. Slopes range from 0 to 2 percent. These soils formed in alluvium.

This association occupies 16,130 acres, or about 1 percent of the county. It is about 26 percent Lex soils, 25 percent Cass soils, 14 percent Lute soils, and 35 percent soils of minor extent.

The Lex soils are moderately deep over coarse sand and are somewhat poorly drained. Typically, the surface layer is very dark gray, friable, calcareous loam about 5 inches thick. The subsurface layer is dark gray, friable, calcareous loam about 5 inches thick. The transitional layer is mottled gray, firm, calareous silty clay loam about 15 inches thick. The underlying material extends to a depth of about 60 inches. It is mottled, grayish brown clay loam in the upper part and light brownish gray, coarse sand in the lower part.

The Cass soils are deep and well drained. Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 5 inches thick. The subsurface layer is dark gray, very friable fine sandy loam about 13 inches thick. The transitional layer is about 12 inches thick. It is grayish brown, very friable fine sandy loam that has thin strata of loamy fine sand. The underlying material extends to a depth of more than 60 inches. It is light brownish gray loamy fine sand stratified with fine sandy loam in the upper part and very pale brown fine sand in the lower part.

The Lute soils are deep and somewhat poorly drained. They are high in sodium content. Typically, the surface layer is gray, friable loam about 4 inches thick. The subsoil is about 19 inches thick. It is dark gray and gray, firm, calcareous loam in the upper part and light gray, friable, calcareous fine sandy loam in the lower part. The underlying material extends to a depth of more than 60

inches. It is mottled, light gray, calcareous loamy fine sand in the upper part and light brownish gray sand in the lower part. The underlying material is stratified with loamy sand to loam.

Of minor extent in this association are Gannett, Lamo, and Ord soils. Gannett soils are lower on the landscape and are poorly drained or very poorly drained. Lamo and Ord soils are in similar positions as the Lex and Lute soils. Lamo soils have dark upper layers that are more than 20 inches thick. Ord soils contain more sand in the underlying material.

Most areas of this association are used as cropland. The remaining areas are in native grass that is used for rangeland or hayland. Most of the cropland is irrigated. Corn and alfalfa are the main irrigated crops. Gravity or sprinkler irrigation systems are suited to the soils in this association. Ground water supplies are suitable for irrigation. Areas that are dryfarmed are used mostly for small grains and alfalfa. Farms are diversified, consisting of a combination of cash grain and livestock enterprises.

Alkali, wetness, and soil blowing are the main management problems. The alkali content in the Lute soils restricts growth of some kinds of crops. Crops do not grow well on Lute soils because moisture and nutrients are not readily available to plants. Reclamation of alkali soils is difficult and expensive; the problems need to be fully investigated. The seasonal high water table causes the soil to warm up slowly in the spring, and the wetness delays tillage operations. Tile drains or open drainage ditches can be installed to lower the water table if suitable outlets are available. Soil blowing can be controlled by keeping the soils covered with crops or crop residue. Maintaining fertility and managing irrigation water are also concerns of management. Range management that includes proper grazing use, timely deferment from grazing or haying, and restricted use during very wet periods helps to maintain or improve the range condition.

5. Inavale-Barney-Boel association

Deep, nearly level, somewhat excessively drained, sandy soils and poorly drained and somewhat poorly drained, silty and loamy soils that are deep and shallow over sand; on bottom lands

This association consists of soils on bottom lands along the Elkhorn and Niobrara Rivers. Areas of these soils are subject to flooding. Slopes range from 0 to 2 percent. These soils formed in alluvium.

This association occupies 11,356 acres, or about 0.7 percent of the county. It is about 48 percent Inavale soils, 19 percent Barney soils, 17 percent Boel soils, and 16 percent soils of minor extent.

The Inavale soils are deep and somewhat excessively drained. They are on the higher bottom land positions that rarely flood. The water table is normally below a depth of 6 feet during the summer, but it may be higher in the spring when nearby streams are at full flow from runoff and snowmelt. Typically, the surface layer is grayish brown, loose fine sand about 9 inches thick. The transitional layer is pale brown, loose fine sand about 5 inches thick. The underlying material is fine sand stratified with loamy sand and sand to a depth of more than 60 inches. It is gray in the upper part and light gray in the lower part. Mottles are below a depth of 44 inches.

The Barney soils are shallow over coarse sand. They are poorly drained. These soils are on the lowest part of the flood plain and are frequently flooded. The seasonal high water table ranges from the surface to a depth of about 2 feet in most years. Typically, the surface layer is gray, very friable silt loam about 8 inches thick. It has thin strata of loamy fine sand and sand. The underlying material to a depth of about 60 inches is light gray, mottled, loose fine sand stratified with fine sandy loam and loamy fine sand in the upper part and white coarse sand stratified with fine sand in the lower part.

The Boel soils are deep and somewhat poorly drained. They are occasionally flooded. The seasonal high water table ranges from a depth of 1.5 feet in wet years to about 2.5 feet in dry years. It normally recedes to a depth of 4 to 6 feet during midsummer. Typically, the surface layer is dark gray, calcareous, very friable loamy fine sand about 11 inches thick. The transitional layer is grayish brown, calcareous, very friable loamy fine sand about 6 inches thick. The underlying material extends to a depth of more than 60 inches. It is mottled, light brownish gray and white fine sand stratified with thin lenses of loamy fine sand.

Of minor extent in this association are Loup and Marlake soils. Also included are small areas of Riverwash. Loup soils are in similar positions as Barney soils, but they lack the stratification in the upper part. Marlake soils are in the lowest positions on the landscape and have water over the surface for a longer period of time. Riverwash is unstabilized, stratified sediment and occurs as sandbars and islands.

Most areas of this association are in native grass and are used as rangeland. Many areas are covered with trees and brush. The Barney soils are too wet for use as cropland. Some of the larger areas of Boel and Inavale soils are suited to cropland. Other areas are dissected by streams or drainage channels, making them unsuited to cultivation. Few farmsteads are in this association because of the wetness and flooding. Farms and ranches are located in adjoining associations and are diversified, mainly a combination of cash grain and livestock enterprises.

Range management that includes proper grazing use, timely deferment from grazing, and restricted use during very wet periods helps to maintain or improve the range

condition. Soil blowing is a hazard on the Inavale soil if the native grass cover is destroyed and the surface is left unprotected. Wetness and flooding are hazards on the Barney and Boel soils. Wetness causes the Boel soil to warm up slowly in the spring and delays tillage operations. Streambank erosion and other damage from floodwater are hazards in places. Areas used for cropland may need to be diked as protection from flooding.

gently sloping to very steep soils on upland breaks

Three associations are in this group. Some of these soils are deep to shallow over bedrock. Others are moderately deep or shallow over gravelly coarse sand. They are excessively drained and well drained, sandy, loamy, and clayey soils that formed in windblown and alluvial material or residuum of sandstone, siltstone, and shale. The steep and very steep soils are used as rangeland. A large part of the remaining acreage is also in rangeland, but some is used for cropland irrigated by center-pivot sprinkler systems from deep wells. Soil blowing and water erosion are the main hazards. Conserving soil moisture, maintaining a high level of fertility, and improving the range condition are other concerns of management.

6. O'Neill-Meadin-Jansen association

Gently sloping to steep, excessively drained and well drained, loamy soils that are moderately deep and shallow over sand and gravel; on uplands

This association consists of soils on divides and side slopes in the Niobrara River breaks (fig. 6). The areas are dissected by deep drainageways that cut back into the tablelands. Slopes range from 2 to 30 percent. These soils formed in loamy material over outwash sand and gravel.

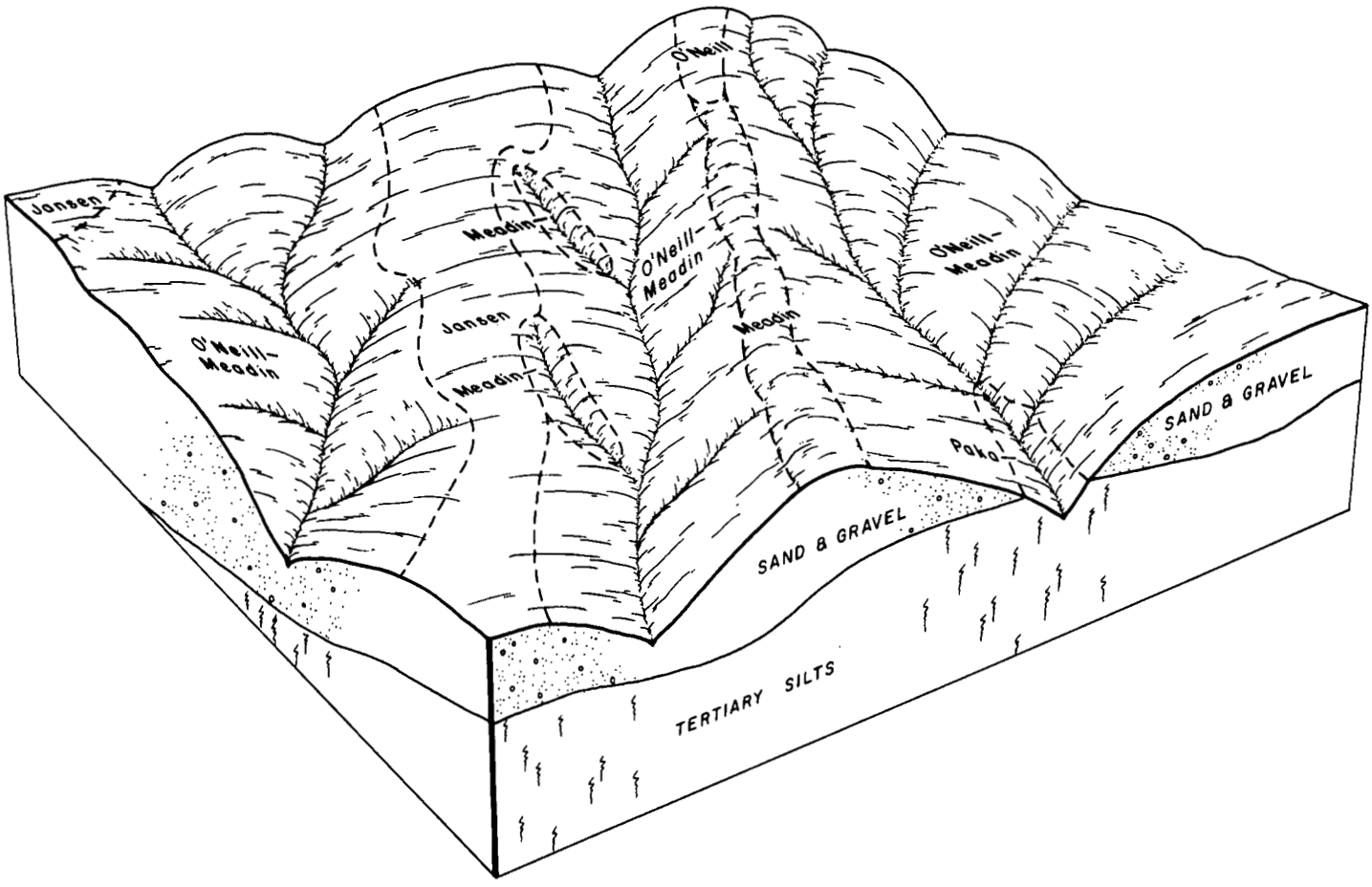


Figure 6.—Typical pattern of soils in the O'Neill-Meadin-Jansen association and their relationship to topography and parent material.

This association occupies 118,479 acres, or about 8 percent of the county. It is about 41 percent O'Neill soils, 32 percent Meadin soils, 12 percent Jansen soils, and 15 percent soils of minor extent.

The O'Neill soils are gently sloping to steep and are well drained. They are moderately deep over gravelly coarse sand. Typically, the surface layer is dark gray, very friable fine sandy loam about 5 inches thick. The subsurface layer is dark grayish brown, very friable fine sandy loam about 7 inches thick. The subsoil, about 14 inches thick, is grayish brown, very friable fine sandy loam in the upper part and brown, very friable sandy loam in the lower part. The underlying material is light yellowish brown, gravelly coarse sand to a depth of more than 60 inches.

The Meadin soils are gently sloping to steep and are excessively drained. They are shallow over gravelly coarse sand. They occupy upper side slopes and ridgetops. Typically, the surface layer is dark grayish brown, very friable sandy loam about 8 inches thick. The transitional layer is brown, very friable sandy loam about 4 inches thick. The underlying material is gravelly coarse sand that extends to a depth of more than 60 inches. The upper part is brown and the lower part is very pale brown.

The Jansen soils are gently sloping and well drained. They are on upland side slopes and are moderately deep over gravelly coarse sand. Typically, the surface layer is dark gray, friable loam about 11 inches thick. The subsoil is about 19 inches thick. It is dark grayish brown, very friable loam in the upper part and brown, friable sandy clay loam in the lower part. The underlying material is very pale brown, gravelly coarse sand that extends to a depth of more than 60 inches.

Of minor extent in this association are Anselmo, Inavale, Pivot, and Paka soils. Anselmo soils do not have gravelly coarse sand and are on foot slopes and stream terraces. Inavale soils are sandy and on bottom lands along intermittent drainageways that are subject to frequent flooding. Pivot soils are sandy and on foot slopes and stream terraces. Paka soils are deep, loamy soils on lower upland side slopes. They have siltstone at a depth of 40 to 60 inches.

Most areas of this association are in native grass and are used as rangeland. The soils that are cultivated are mainly moderately deep and gently sloping. Alfalfa and small grains are the main dryland crops. On irrigated land, corn and alfalfa are the main crops. Irrigation potential is limited because underground water supplies are not always available in quantities needed for irrigation and because of the steepness of slopes. Water supply is sufficient for livestock and domestic use. Farms and ranches in this association are diversified, mainly a combination of cash grain and livestock enterprises.

Range management that includes proper grazing use, timely deferment from grazing, and a system of use and rest with the order changed each year helps to maintain or improve the range condition. Water erosion and soil blowing are hazards in cultivated areas. The moderate to low available water capacity is a limitation. On cultivated land, maintaining crop residue on the surface, stripcropping, and minimum tillage help to control erosion and conserve moisture.

7. O'Neill-Brunswick-Paka association

Deep and moderately deep, gently sloping to steep, well drained, loamy soils; on uplands

This association consists of soils on the breaks to the Niobrara River. Most areas are deeply dissected by drainageways. Slopes range from 2 to 30 percent.

This association occupies 65,435 acres, or about 4 percent of the county. It is about 25 percent O'Neill soils, 14 percent Brunswick soils, 12 percent Paka soils, and 49 percent soils of minor extent.

The O'Neill soils are strongly sloping to steep and are well drained. They are moderately deep over gravelly coarse sand and are on upland side slopes. Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 9 inches thick. The subsoil is brown, very friable sandy loam about 13 inches thick. The underlying material is very pale brown, gravelly coarse sand to a depth of more than 60 inches.

The Brunswick soils are strongly sloping to steep and are well drained. These moderately deep soils formed in material weathered from sandstone on upland side slopes. Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 4 inches thick. The subsoil is very friable fine sandy loam about 12 inches thick. The upper part is grayish brown and the lower part is light brownish gray. The underlying material is light gray loamy fine sand to a depth of 24 inches. White, soft sandstone extends to a depth of 60 inches or more.

The Paka soils are gently sloping to strongly sloping and are well drained. They are deep soils that formed in material weathered from siltstone on the lower upland side slopes. Typically, the surface layer is dark grayish brown, very friable loam about 9 inches thick. The subsoil is about 17 inches thick. The upper part of the subsoil is grayish brown, very friable silty clay loam; the middle part is brown, very friable silt loam; and the lower part is pale brown, very friable silt loam. The underlying material is very pale brown, calcareous silt loam. At a depth of 44 inches is white, calcareous, weakly cemented siltstone.

Of minor extent in this association are Dunday, Meadin, Pivot, and Tassel soils. Dunday and Pivot soils are sandy and are mostly on foot slopes and stream terraces. Meadin and Tassel soils are on upper side slopes and shoulders along drainageways. Meadin soils

are shallow over gravelly coarse sand. Tassel soils have sandstone at a depth of 10 to 20 inches.

Most areas of this association are in native grass and are used as rangeland. Areas that are cultivated are mainly gently sloping to strongly sloping. Alfalfa and small grains are the main crops grown under dryland management. On irrigated land, alfalfa and corn are the principal crops. Irrigation potential is limited because ground water supplies are not always available in quantities needed for irrigation and because of the steepness of the slopes. The water from wells is sufficient for livestock and domestic use. Farms and ranches in this association are diversified, mainly a combination of cash grain and livestock enterprises.

Range management that includes proper grazing use, timely deferment from grazing, or a system of use and rest with the order changed each year helps to maintain or improve the range condition. Water erosion is a hazard in cultivated areas. Keeping an adequate cover of crops and crop residue helps to control erosion and conserve soil moisture. Maintaining fertility is also a concern of management.

8. Labu-Sansarc-Valentine association

Deep to shallow, moderately steep to very steep, excessively drained and well drained, clayey and sandy soils; on uplands

This association consists of soils on shoulders and side slopes along the deeply entrenched Niobrara River and its tributaries. The clayey soils formed in shale and are mostly on the north- and west-facing slopes. The sandy soils formed in windblown sand, mostly on the south- and east-facing slopes where the sand overlies the shale. In a few places, sandy soils are on upper side slopes or at the upper end of the drainageways, and the clayey soils are on the lower side slopes. Slopes range from 11 to 40 percent.

This association occupies 48,182 acres, or about 3 percent of the county. It is about 36 percent Labu soils, 14 percent Sansarc soils, 12 percent Valentine soils, and 38 percent soils of minor extent (fig. 7).

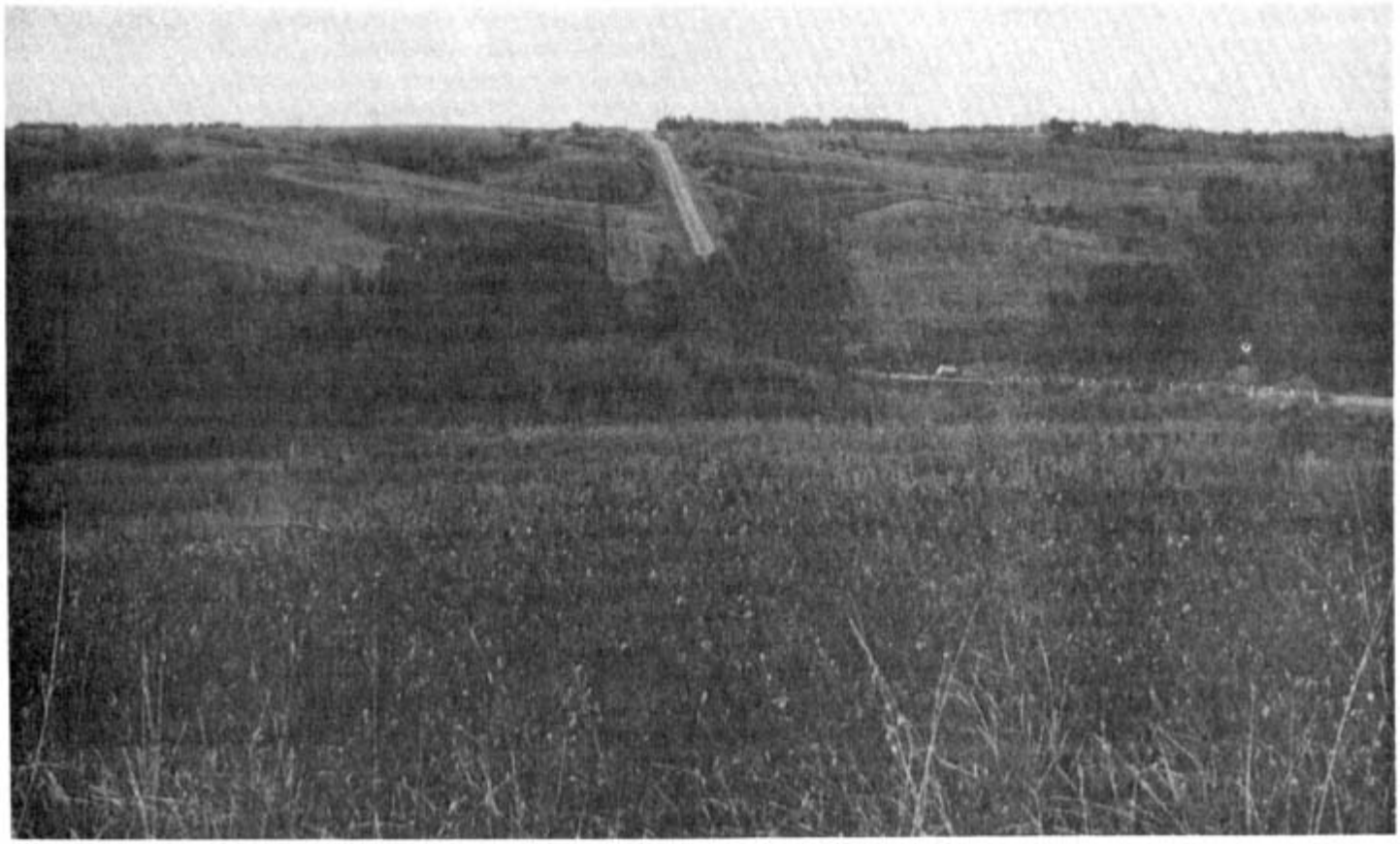


Figure 7.—Typical landscape in the Labu-Sansarc-Valentine association. Labu and Sansarc soils are on the north-facing slopes in the background. The Valentine soils are on the south-facing slopes in the foreground.

The Labu soils are moderately deep, well drained, and clayey. They are on moderately steep to steep side slopes along drainageways. Typically, the surface layer is dark grayish brown, firm silty clay about 5 inches thick. The subsoil is light olive brown, firm silty clay about 15 inches thick. The lower part is calcareous. The underlying material, about 4 inches thick, is light olive brown, calcareous shaly clay. Light yellowish brown, calcareous, bedded shale is at a depth of about 24 inches.

The Sansarc soils are shallow, well drained, and clayey. They are on steep and very steep upper side slopes and narrow ridgetops. Typically, the surface layer is dark grayish brown, calcareous, firm silty clay about 4 inches thick. The underlying material, about 8 inches thick, is pale brown, calcareous shaly clay. Pale brown and light yellowish brown, calcareous bedded shale is at a depth of 12 inches.

The Valentine soils are deep, excessively drained, and sandy. They are on steep and very steep side slopes along drainageways. Typically, the surface layer is light brownish gray, loose fine sand about 3 inches thick. The underlying material is very pale brown fine sand to a depth of more than 60 inches.

Of minor extent in this association are Boel, Cass, Simeon, and Verdel soils. Boel and Cass soils are on bottom lands along the drainageways. Boel soils are sandy and somewhat poorly drained. Cass soils are loamy and well drained. Simeon soils are in similar positions as Valentine soils and contain more gravel. Verdel soils are on stream terraces. They are deep, clayey soils that have dark upper layers that are more than 20 inches thick.

Most areas of this association are in native grass and are used as rangeland. Soils in this association are generally too steep or too clayey for use as cropland. Some of the less sloping areas can be hayed or cropped to dryland alfalfa. Some of the small areas on bottom lands and stream terraces can be used as dryfarmed or irrigated cropland. Ground water supplies are not reliable. Wells dug in this area are deep and usually yield water of poor quality. Flowing streams in the association usually provide water for livestock. Some precipitation is caught and stored in stockwater ponds. The farms and ranches in this association include soils in adjacent associations. They are diversified, mainly a combination of cash grain and livestock enterprises.

Range management that includes proper grazing use, timely deferment from grazing, and a system of use and rest with the order changed each year helps to maintain or improve the range condition. Water erosion and droughtiness are management problems on clayey soils used for rangeland or cropland. Maintaining an adequate vegetative cover and ground mulch helps to prevent soil losses by erosion and improves the moisture supply by reducing runoff. Soil blowing is a hazard on the sandy soils if the grass cover is destroyed.

nearly level to gently sloping soils on tablelands and stream terraces

Two associations are in this group. The soils are deep or moderately deep over coarse sand or gravelly coarse sand. They are somewhat excessively drained to moderately well drained, sandy and loamy soils that formed in windblown and alluvial material. Most of the acreage of this group of soils is used for cropland, and much of it is irrigated by center-pivot sprinkler systems from deep wells. The rest of the area is used mostly for rangeland. Soil blowing is a hazard on the sandy soils. Conserving soil moisture and managing irrigation water are other concerns of management.

9. Dunday-Pivot-Dunn association

Deep, nearly level to gently sloping, somewhat excessively drained and moderately well drained, sandy soils; on tablelands and stream terraces

This association consists of soils on tablelands. The soils formed in sandy outwash or windblown sands overlying deposits of sand, gravel, or loamy alluvium. Slopes range from 0 to 6 percent (fig. 8).

This association occupies 106,806 acres, or about 7 percent of the county. It is about 32 percent Dunday soils, 30 percent Pivot soils, 11 percent Dunn soils, and 27 percent soils of minor extent.

The Dunday soils are deep and are nearly level to gently sloping. They formed in windblown sands. Dunday soils are somewhat excessively drained. Typically, the surface layer is dark gray, very friable loamy sand about 7 inches thick. The subsurface layer is dark grayish brown, very friable loamy sand about 10 inches thick. The underlying material is pale brown and very pale brown fine sand to a depth of more than 60 inches.

The Pivot soils are nearly level to very gently sloping and are somewhat excessively drained. Typically, the surface layer is dark gray, very friable loamy sand about 6 inches thick. The subsurface layer is dark grayish brown, very friable loamy sand about 10 inches thick. The transitional layer is grayish brown, very friable loamy sand about 5 inches thick. The underlying material extends to a depth of more than 60 inches. It is brown coarse sand in the upper part and pale brown, gravelly coarse sand in the lower part.

The Dunn soils are nearly level to very gently sloping and are moderately well drained. They formed in windblown sand over loamy alluvium. Typically, the surface layer is dark grayish brown, very friable loamy sand about 12 inches thick. The transitional layer is grayish brown, very friable sand about 5 inches thick. The underlying material is mottled, pale brown sand

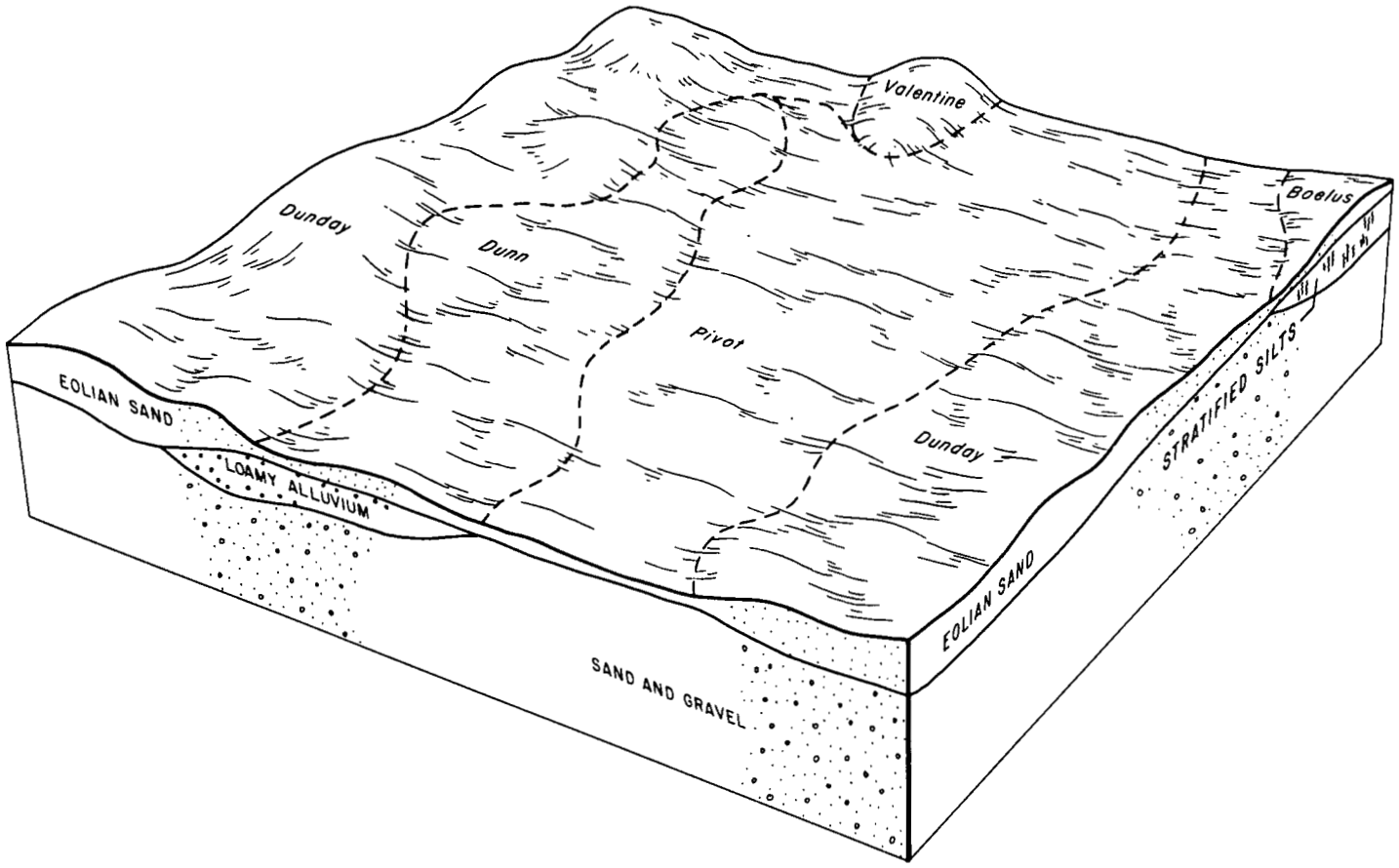


Figure 8.—Typical pattern of soils in the Dunday-Pivot-Dunn association and their relationship to topography and parent material.

about 11 inches thick. Below this is a layer of mottled, light brownish gray sandy clay loam about 14 inches thick. Beneath this is mottled, light gray sandy clay loam to a depth of more than 60 inches.

Of minor extent in this association are Boelus, Elsmere, and Valentine soils. Boelus soils are in similar positions as Dunn soils and are well drained. Elsmere soils are lower on the landscape and are somewhat poorly drained. Valentine soils are higher on the landscape and are excessively drained.

Most areas of this association are cropland, and almost all of it is irrigated. The rest of the area is in native grass and is used as rangeland. Some is harvested for hay. These soils are too sandy for gravity irrigation. Sprinkler irrigation is well suited because these soils require frequent, light applications of water. Corn and alfalfa are the main irrigated crops. Farms and ranches in this association are diversified, mainly a combination of cash grain and livestock enterprises.

Soil blowing is the main hazard in cultivated areas. In areas of Dunn soils, wetness can be a problem in low areas and swales. Soils in this association have low or moderate available water capacity and are droughty. Soil blowing can be controlled by maintaining a cover of grass, crops, or crop residue on the surface. Artificial drainage can be needed to reduce wetness problems in areas of Dunn soils. Irrigation water management is a major concern when using these soils for irrigated cropland. Improving the organic matter content and maintaining fertility are also important concerns of management. Range management that includes proper grazing use, timely deferment from grazing or haying, and a system of use and rest with the order changed each year helps to maintain or improve the range condition.

10. Jansen-O'Neill association

Nearly level, well drained, loamy soils that are moderately deep over sand and gravel; on tablelands

This association consists of soils on tablelands on the divide between the Elkhorn River and Niobrara River

watersheds. Slopes range from 0 to 2 percent (fig. 9). The soils formed in loamy sediment over outwash sand and gravel.

This soil association occupies 86,711 acres, or about 6 percent of the county. It is about 60 percent Jansen soils, 23 percent O'Neill soils, and 17 percent soils of minor extent.

The Jansen soils are moderately deep over gravelly coarse sand. Typically, the surface layer is dark gray, friable loam about 6 inches thick. The subsurface layer is similar to the surface layer in color and texture and is about 6 inches thick. The subsoil is about 18 inches thick. The upper part of the subsoil is dark grayish brown, friable loam; the middle part is brown, firm loam and sandy clay loam; and the lower part is light yellowish brown, very friable loamy coarse sand. The underlying material to a depth of more than 60 inches is very pale brown, gravelly coarse sand.

The O'Neill soils are moderately deep over coarse sand. Typically, the surface layer is grayish brown, very friable fine sandy loam about 8 inches thick. The subsurface layer is dark grayish brown, very friable fine sandy loam about 4 inches thick. The subsoil is brown, very friable fine sandy loam about 14 inches thick. The underlying material extends to a depth of more than 60 inches. It is pale brown sand in the upper part and very pale brown, coarse sand in the lower part.

Of minor extent in this association are Anselmo, Dunday, and Meadin soils. Anselmo and Dunday soils are deep and are higher on the landscape. Anselmo soils have sandy underlying material. Dunday soils are sandy throughout the profile. Meadin soils are lower on the landscape and have gravelly coarse sand at a depth of 8 to 20 inches.

About 80 percent of this association is in cropland, and a large acreage is irrigated. The rest is in native grass and is used as rangeland. Corn, small grains, and alfalfa are the main dryland crops. Wheat and the first cutting of alfalfa are the most dependable crops, because they grow and mature in spring when the rainfall is usually highest. Corn and alfalfa are the main irrigated crops. Gravity or sprinkler irrigation systems are suited to these soils. Some land grading may be needed to smooth areas for gravity irrigation. Well yields are

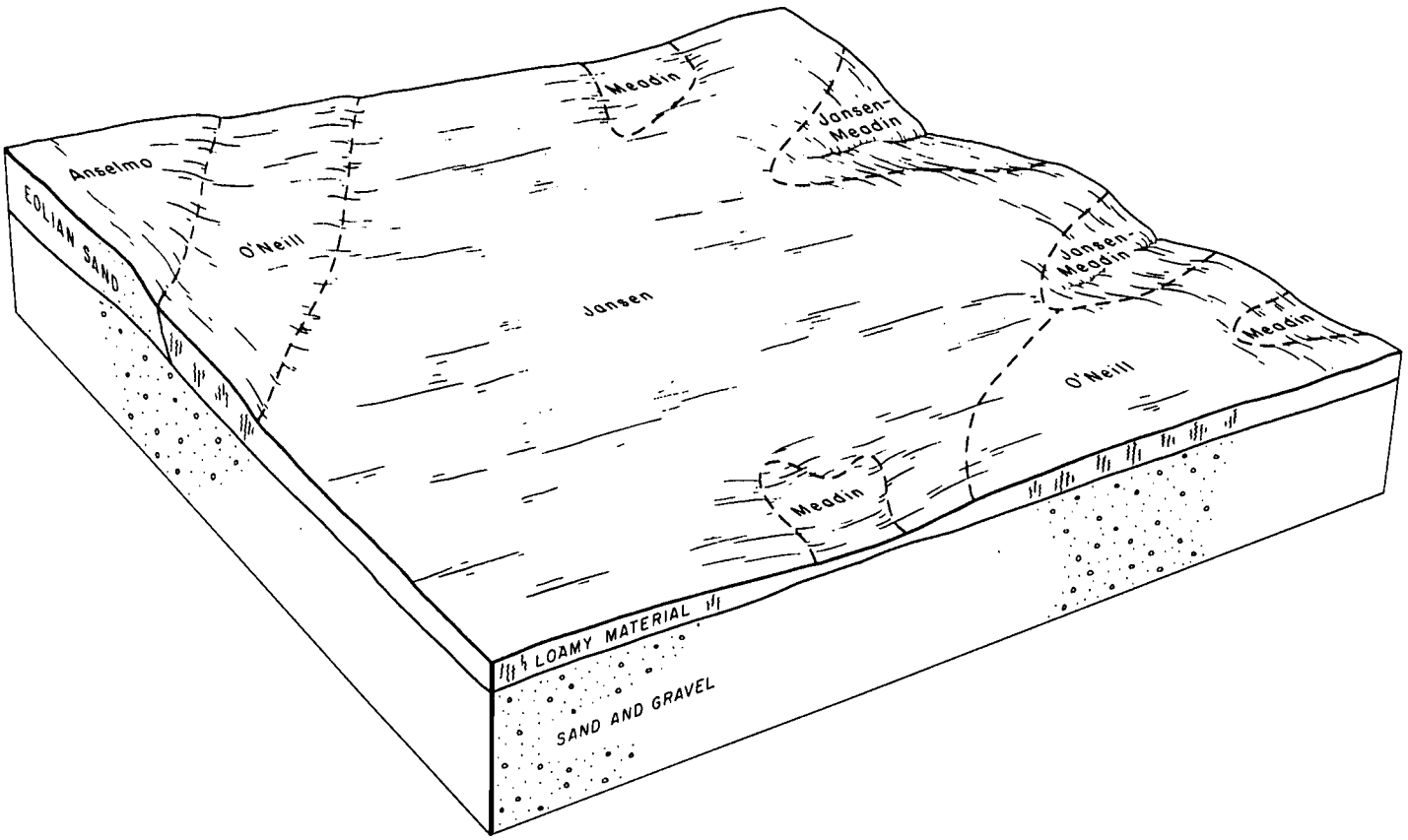


Figure 9.—Typical pattern of soils in the Jansen-O'Neill association and their relationship to topography and parent material.

variable, depending on the availability of ground water. Irrigation potential in some areas is limited because ground water supplies are not available in quantities needed for irrigation. Farms in this association are diversified, mainly a combination of cash grain and livestock enterprises.

Inadequate seasonal rainfall is the main concern if these soils are dryfarmed. The soils have low or moderate available water capacity and are droughty. Stubble mulch tillage and other management practices that keep crop residue on the surface help to control soil blowing and conserve soil moisture. Managing irrigation water and maintaining fertility are concerns in managing irrigated areas. Range management that includes proper grazing use, timely deferments from grazing, and a system of use and rest with the order changed each year helps to maintain or improve the range condition.

nearly level to steep soils on uplands and stream terraces

There are two associations in this group. The soils are deep, excessively drained to well drained, and sandy. They formed in windblown and alluvial material. Soils of this group are used about equally for cropland and rangeland. Most of the cropland is irrigated by center-pivot sprinkler systems from deep wells. Soil blowing is the main hazard if these soils are farmed. Conserving soil moisture, improving fertility, and managing irrigation water are other concerns in farmed areas. Improving the condition of the range is a concern in areas still in native grass.

11. Valentine-Simeon-Dunday association

Deep, nearly level to steep, excessively drained and somewhat excessively drained, sandy soils; on uplands and stream terraces

This association is on the high, geological terrace overlooking the Niobrara River. Slopes range from 0 to 30 percent. The terrace ranges from about 3 to 5 miles in width and is cut through in places by drainageways that flow to the Niobrara River.

This association occupies 62,046 acres, or about 4 percent of the county. It is about 37 percent Valentine soils, 35 percent Simeon soils, 10 percent Dunday soils, and 18 percent soils of minor extent.

The Valentine soils are nearly level to steep, excessively drained soils that formed in windblown sand. Typically, the surface layer is grayish brown, loose fine sand about 8 inches thick. The transitional layer is brown, loose fine sand about 7 inches thick. The underlying material is pale brown and very pale brown fine sand to a depth of more than 60 inches.

The Simeon soils are nearly level to steep, excessively drained soils that formed in sandy alluvium and outwash material. Typically, the surface layer is grayish brown, very friable loamy sand about 8 inches thick. The transitional layer is brown, loose sand about 10 inches thick. The underlying material extends to a depth of more than 60 inches. It is light yellowish brown, coarse sand in the upper part and very pale brown sand in the lower part.

The Dunday soils are level to very gently sloping, somewhat excessively drained soils that formed in windblown sand. Typically, the surface layer is dark gray, very friable loamy fine sand about 8 inches thick. The subsurface layer is dark grayish brown, very friable loamy fine sand about 6 inches thick. The transitional layer is grayish brown, very friable loamy fine sand about 6 inches thick. The underlying material is fine sand to a depth of more than 60 inches. It is pale brown in the upper part and very pale brown in the lower part.

Of minor extent in this association are Labu, Pivot, and O'Neill soils. Labu soils are clayey and are on the lower side slopes of drainageways that dissect the area. Pivot and O'Neill soils are on flat stream terraces. They have coarse sand or gravelly coarse sand at a depth of 20 to 40 inches.

Nearly all of this association is in native grass and is used as rangeland. Most soils in this association are too droughty for dryland farming. A few areas are used for irrigated cropland. Corn and alfalfa are the main irrigated crops. Only sprinkler irrigation systems are suited to these soils. The soils are too sandy for gravity irrigation. Light, frequent applications of irrigation water are needed to avoid leaching. Irrigation development is limited because ground water supplies generally are not dependable. In places, water for irrigation is pumped from nearby streams. Wells can usually be obtained for livestock and domestic uses. Farms and ranches in this association are diversified and consist mainly of cash grain and livestock enterprises.

Range management that includes proper grazing use, timely deferment from grazing, and a system of use and rest with the order changed each year helps to maintain or improve the range condition. Soil blowing is a hazard if the grass cover is destroyed. Soils in this association are droughty because they have low available water capacity. In cultivated areas, the soils need to be protected by a cover of grass, crops, or crop residue to control soil blowing and conserve moisture. Inadequate seasonal rainfall limits grass production in most years. Maintaining fertility, conserving soil moisture, and managing irrigation water are management concerns in irrigated areas.

12. Dunday-Valentine-Boelus association

Deep, nearly level to strongly sloping, excessively drained to well drained, sandy soils; on uplands

This association consists of soils on uplands that are in transitional areas between areas of sandy soils and areas of loamy soils. Sandy and loamy material is intermixed in this association, but the material is predominantly sandy. Slopes range from 0 to 11 percent.

This association occupies 50,029 acres, or about 3 percent of the county. It is about 38 percent Dunday soils, 36 percent Valentine soils, 15 percent Boelus soils, and 11 percent soils of minor extent.

The Dunday soils are level to gently sloping and somewhat excessively drained. They formed in wind-deposited sand. Typically, the surface layer is dark gray, very friable loamy sand about 7 inches thick. The subsurface layer is dark grayish brown, very friable loamy sand about 10 inches thick. The transitional layer is brown, very friable sand about 11 inches thick. The underlying material is pale brown and very pale brown fine sand to a depth of more than 60 inches.

The Valentine soils are nearly level to strongly sloping and excessively drained. They formed in wind-deposited sand. Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 5 inches thick. The transitional layer is grayish brown, loose fine sand about 5 inches thick. The underlying material is pale brown fine sand to a depth of more than 60 inches.

The Boelus soils are nearly level to gently sloping and well drained. They formed in windblown sand over loamy sediment. Typically, the surface layer is dark grayish brown, very friable loamy sand about 12 inches thick. The subsurface layer is about 14 inches thick. It is grayish brown, very friable loamy sand in the upper part and brown, loose sand in the lower part. The subsoil is pale brown, friable silty clay loam about 10 inches thick. The underlying material is light yellowish brown silty clay loam to a depth of more than 60 inches.

Of minor extent in this association are Anselmo, Nora, and Paka soils. The Anselmo and Nora soils are on nearly level uplands. Anselmo soils are loamy. Nora soils are silty and formed in loess. Paka soils are on upland side slopes. They have a silty subsoil and siltstone at a depth of 40 to 60 inches.

Most areas of this association are in cropland. The rest are in native grass and are used as rangeland. Many areas are dryfarmed to corn, small grains, and alfalfa. A large acreage of the cropland is under center-pivot irrigation. Corn and alfalfa are the main irrigated crops. High producing wells suitable for irrigation can usually be obtained in this association. Soils in this association are too sandy for gravity irrigation. Farms in this association are a combination of cash grain and livestock operations.

Soil blowing is the main hazard if these soils are farmed. Stubble mulch tillage and other management practices that keep all or part of the crop residue on the surface help to control soil blowing and conserve soil moisture. Maintaining fertility and organic matter content are concerns under dryland and irrigation management. Irrigation water management is a major concern in irrigated areas. Range management that includes proper grazing use or a system of use and rest with the order changed each year helps to control erosion and maintain or improve the range condition.

nearly level to gently sloping soils on uplands, foot slopes, and stream terraces

Two associations are in this group. The soils are deep, moderately deep, and moderately deep over gravelly coarse sand. They are somewhat excessively drained to somewhat poorly drained, sandy and loamy soils that formed in windblown and alluvial material or in residuum of shale. The areas of this group are used as dryfarmed cropland and for native grass. A small acreage is irrigated by center-pivot sprinkler systems, mostly from ponds or flowing streams. The rest of the area is used as rangeland. Soil blowing is the main hazard. Conserving soil moisture, increasing fertility, and improving the condition of the range are other concerns of management.

13. Wewela-Dunday-Elsmere association

Deep and moderately deep, nearly level to gently sloping, somewhat excessively drained, well drained, and somewhat poorly drained, loamy and sandy soils; on uplands and stream terraces

This association is on uplands and stream terraces where shale is covered by thin to thick deposits of windblown and alluvial material. In places, a water table is perched above the shale. Slopes range from 0 to 6 percent. In a few places, there are gently sloping soils on shale ridges and soils formed in windblown sand that has been reworked into hummocky topography.

This association occupies 43,370 acres, or about 3 percent of the county. It is about 22 percent Wewela soils, 20 percent Dunday soils, 10 percent Elsmere soils, and 48 percent soils of minor extent.

The Wewela soils are moderately deep, nearly level to gently sloping, well drained soils on uplands. They formed in loamy windblown material deposited over clayey material weathered from shale. Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 8 inches thick. The subsoil is about 18 inches thick. It is light olive brown, friable sandy clay loam in the upper part and light brownish gray and light yellowish brown, firm clay in the lower part. The underlying material is light yellowish brown and brownish yellow, calcareous shaly clay about 12 inches thick. Light yellowish brown and yellow bedded shale is at a depth of about 38 inches.

The Dunday soils are deep, nearly level to gently sloping, somewhat excessively drained soils on uplands

and stream terraces. They formed in windblown sand. Typically, the surface layer is dark gray, very friable loamy sand about 7 inches thick. The subsurface layer is dark grayish brown, very friable loamy sand about 10 inches thick. The transitional layer is brown, very friable sand about 11 inches thick. The underlying material is pale brown and very pale brown fine sand to a depth of more than 60 inches.

The Elsmere soils are deep, nearly level, somewhat poorly drained soils on stream terraces. They formed in windblown or alluvial sands deposited over clayey shale. A water table is perched above the clayey material in spring and during wet periods, but it dries up over much of the area in the summer. The seasonal high water table ranges from a depth of about 1.5 feet in wet years to about 2.5 feet in dry years. Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 12 inches thick. The transitional layer is grayish brown, very friable loamy fine sand about 8 inches thick. The underlying material is very pale brown, mottled fine sand to a depth of 56 inches. Light yellowish brown gray silty clay extends to a depth of more than 60 inches.

Of minor extent in this association are Anselmo, Ipage, Labu, O'Neill, Paka, and Valentine soils. Anselmo, O'Neill, and Valentine soils are on the higher parts of the landscape. Anselmo and O'Neill soils have a loamy subsoil. O'Neill soils are moderately deep over coarse sand and gravelly coarse sand. Valentine soils are sandy. Ipage soils are higher on the landscape than Elsmere soils and are moderately well drained. Paka and Labu soils are mostly on ridges and knolls. Paka soils are silty. Labu soils are clayey.

A large acreage of this association is in cropland, and the rest is in native grass and is used as rangeland or hayland. Some areas of this association are suited to irrigation. Irrigation water is pumped mostly from flowing streams, because ground water supplies are not dependable nor available in the quantities needed for irrigation. Sprinkler irrigation is best suited. Corn is the main irrigated crop. Alfalfa, corn, and small grains are the main dryland crops. Farms and ranches are diversified, consisting of cash grain and livestock enterprises.

Soil blowing is a severe hazard on the sandy soils if the grass cover is destroyed. Keeping a cover of crop residue on the surface helps to control soil blowing and conserve moisture. Wewela soils have low available water capacity and are droughty. Wetness caused by the water table can be a problem in areas of Elsmere soils in the spring or during periods of above normal rainfall. Maintaining fertility is a problem under dryland and irrigation management. Range management that includes proper grazing use, timely deferment from grazing or haying, and restricted use during very wet periods helps to maintain or improve the range condition.

14. O'Neill-Anselmo-Pivot association

Nearly level to gently sloping, somewhat excessively drained and well drained, loamy and sandy soils that are deep and moderately deep over sand and gravel; on uplands, foot slopes, and stream terraces

This association is on geological terraces along tributaries of the Niobrara River. It consists of soils on uplands and stream terraces. Slopes range from 0 to 6 percent. In places, the geological terraces are dissected by tributaries of the Niobrara River, which originate in the uplands and flow northward to the river. The drainageways range from 5 to 50 feet in depth and up to several hundred feet in width. The area between the drains is mostly nearly level with isolated areas of small ridges and knolls.

This association occupies 35,928 acres, or about 2 percent of the county. It is about 27 percent O'Neill soils, 25 percent Anselmo soils, 12 percent Pivot soils, and 36 percent soils of minor extent.

The O'Neill soils are moderately deep over gravelly coarse sand. They are well drained. In a few places, these soils are on low ridges or knolls. Typically, the surface layer is grayish brown, very friable sandy loam about 7 inches thick. The subsurface layer is dark grayish brown, very friable sandy loam about 4 inches thick. The subsoil is brown, very friable sandy loam about 14 inches thick. The underlying material extends to a depth of more than 60 inches. It is pale brown coarse sand in the upper part and very pale brown, gravelly coarse sand in the lower part.

The Anselmo soils are deep and well drained. Typically, the surface layer is dark gray, very friable sandy loam about 7 inches thick. The subsurface layer is grayish brown, very friable sandy loam about 6 inches thick. The subsoil is brown, very friable sandy loam about 14 inches thick. The underlying material is pale brown loamy sand to a depth of more than 60 inches.

The Pivot soils are somewhat excessively drained. They are moderately deep over gravelly coarse sand. Typically, the surface layer is dark gray, very friable loamy sand about 6 inches thick. The subsurface layer is dark grayish brown, very friable loamy sand about 10 inches thick. The transitional layer is grayish brown, very friable loamy sand about 5 inches thick. The underlying material extends to a depth of more than 60 inches. It is brown coarse sand in the upper part and pale brown, gravelly coarse sand in the lower part.

Of minor extent in this association are Dunday, Paka, Jansen, and Valentine soils. Dunday and Valentine soils are higher on the landscape than the major soils and are sandy throughout the profile. Paka soils are mostly on small hills and knolls on the stream terraces and have a silty subsoil. Jansen soils are slightly higher on the landscape and have a loamy subsoil.

Most areas of this association are dryland cropland, or

they are in native grass and used as rangeland. Alfalfa is the main dryland crop. Only a small acreage is irrigated. Irrigation is limited because ground water supplies are not dependable and are not always available in the quantities needed. Some irrigation water is pumped from ponds or streams. Corn and alfalfa are the main irrigated crops. Water is normally available for livestock and domestic uses. Farms and ranches in this association are diversified, consisting mainly of cash grain and livestock enterprises.

Soil blowing is a hazard if the vegetative cover is destroyed. Protecting the soil with crop residue helps to control soil blowing and conserves soil moisture. Insufficient rainfall limits grass and crop production in most years. Maintaining fertility is a problem. Irrigation water management is a concern in irrigated areas. Range management that includes proper grazing use or a system of use and rest with the order changed each year helps to improve or maintain the range condition.

nearly level to gently sloping soils on uplands

There are two associations in this group. The soils are deep, well drained and moderately well drained, loamy and silty soils that formed in windblown and loess-like material or in residuum of siltstone. The areas in this group are used for dryfarmed and irrigated cropland. Irrigation is mostly by center-pivot irrigation systems from deep wells. Areas in native grass are used mostly as rangeland. Water erosion on sloping soils is the main hazard. Conserving soil moisture, improving fertility, and managing irrigation water are other concerns.

15. Paka-Anselmo association

Deep, nearly level to gently sloping, well drained, loamy soils; on uplands

This association consists mostly of loamy soils that formed in material weathered from siltstone and windblown material. Slopes range from 0 to 6 percent (fig. 10).

This association occupies 13,190 acres, or about 0.9 percent of the county. It is about 50 percent Paka soils, 38 percent Anselmo soils, and 12 percent soils of minor extent.

The Paka soils are mostly on upland side slopes and ridgetops. Typically, the surface layer is dark grayish brown, very friable loam about 9 inches thick. The subsoil is about 17 inches thick. The upper part of the subsoil is grayish brown, very friable silty clay loam; the middle part is brown, very friable silt loam; and the lower part is pale brown, very friable silt loam. The underlying material is very pale brown, calcareous silt loam to a

Figure 10.—Typical landscape in the Paka-Anselmo association. These nearly level to gently sloping, silty and loamy soils are suited to dryfarmed and irrigated cropland.

depth of 44 inches. Below this is white, calcareous, weakly cemented siltstone.

The Anselmo soils are on uplands. Typically, the surface layer is grayish brown, very friable fine sandy loam about 6 inches thick. The subsurface layer is dark grayish brown, fine sandy loam about 4 inches thick. The subsoil is brown, very friable fine sandy loam about 14 inches thick. The underlying material is light yellowish brown, loamy fine sand to a depth of more than 60 inches.

Of minor extent in this association are Josburg, Lute, Lawet, and Ord soils. Josburg soils are on nearly level uplands and are slowly permeable in the loamy underlying material. Lute, Lawet, and Ord soils are on bottom lands or foot slopes along drainageways and are somewhat poorly drained. Lute soils are also high in sodium content.

Most areas of this association are used as dryland or irrigated cropland. The remaining acreage is in native grass and is used as rangeland. Corn, small grains, and alfalfa are dryfarmed. Alfalfa and corn are the major irrigated crops. Many good irrigation wells are in this association The soils are suited to gravity or sprinkler irrigation methods, but the steepness of slopes restricts gravity irrigation in most places. Farms in this association are diversified and are mainly combination cash grain and livestock types.

Soil blowing and water erosion are severe hazards if soils in this association are farmed and the surface is not protected by vegetation or crop residue. Wheel track erosion, under center-pivot irrigation, is also a problem on some areas of the gently sloping soils. Under dryland management, inadequate seasonal rainfall and the conservation of soil moisture are major concerns of management. Efficient use of irrigation water, erosion control, and maintenance of soil fertility are concerns under irrigation. Range management that includes proper grazing use or a system of use and rest with the order changed each year helps to maintain or improve the range condition.

16. Bazile-Trent association

Deep, nearly level to gently sloping, well drained and moderately well drained, silty soils; on uplands

This association consists of soils on uplands. Slopes range from 0 to 6 percent.

This association occupies about 6,330 acres, or about 0.4 percent of the county. It is about 62 percent Bazile soils, 34 percent Trent soils, and 4 percent soils of minor extent.

The Bazile soils are nearly level to gently sloping. They are well drained. These soils formed in loess or silty material over outwash sand. Typically, the surface layer is dark grayish brown, friable silt loam about 6 inches thick. The subsurface layer is grayish brown, friable silt loam about 5 inches thick. The friable subsoil is about 20 inches thick. It is brown silty clay loam in the upper part, yellowish brown silty clay loam in the middle part, and light yellowish brown clay loam in the lower part. The underlying material is very pale brown sand to a depth of more than 60 inches.

The Trent soils are nearly level and formed in loess or silty sediment. They are moderately well drained. They occupy flats or swales on the uplands. Typically, the surface layer is dark grayish brown, very friable silt loam about 6 inches thick. The subsurface layer is similar to the surface layer in color and texture and is about 5 inches thick. The friable subsoil is about 29 inches thick. It is dark grayish brown silt loam in the upper part and brown silty clay loam in the lower part. The underlying material is pale brown silty clay loam to a depth of more than 60 inches.

Of minor extent in this association are Fillmore and Jansen soils. Fillmore soils are in upland depressions that pond water for short periods. They have a clayey subsoil. Jansen soils are in similar positions as Bazile soils and have gravelly coarse sand at a depth of 20 to 40 inches.

Most areas of this association are dryfarmed or irrigated cropland. Much of the acreage is under center-pivot irrigation. The main dryfarmed crops are corn, alfalfa, and small grains. Corn and alfalfa are the main irrigated crops. Deep wells supply the irrigation water. Farms in this association are combination cash grain and livestock operations.

Water erosion is the main hazard on the sloping areas of this association. Terraces, contour farming, and stubble mulch tillage help to control erosion and conserve soil moisture. Ponding of water in depressions is a problem, and artificial drainage may be needed. Maintaining fertility is a problem. Irrigation water management is a concern in irrigated areas. The few areas that remain in native grass need range management that includes proper grazing use, timely deferment from grazing, and a system of use and rest with the order changed each year to help maintain or improve the range condition.

detailed soil map units

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

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

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

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

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Jansen loam, 0 to 2 percent slopes, is one of several phases in the Jansen series.

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

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Els-Ipage complex, 0 to 3 percent slopes, is an example.

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

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, sand and gravel, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

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

Some soil boundaries and soil names do not fully match those of adjoining areas that were published at an earlier date. This is a result of changes and refinements in series concepts, different slope groupings, and application of the latest soil classification system.

An—Anselmo fine sandy loam, 0 to 2 percent slopes. This deep, nearly level, well drained soil is on uplands and stream terraces. Individual areas range from 5 to 200 acres.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 7 inches thick. The subsurface layer is similar in color and texture and is about 8 inches thick. The subsoil is brown, very friable fine sandy loam about 14 inches thick. The underlying material is pale brown, loamy fine sand to a depth of more than 60 inches. In a few places, the surface layer is loamy fine sand, sandy loam, or loam. In places, the dark surface soil is more than 20 inches thick. Some areas have loamy material below a depth of 40 inches. In places, fine gravel is scattered throughout the profile.

Included with this soil in mapping are small areas of Dunday, Jansen, Josburg, and O'Neill soils. Dunday soils are on higher ridges and knolls and contain more sand. Jansen, Josburg, and O'Neill soils are lower on the landscape. Josburg soils have loamy material below a depth of 20 inches. Jansen and O'Neill soils have gravelly coarse sand below a depth of 20 inches. Included soils make up 10 to 20 percent of this map unit.

Permeability of this Anselmo soil is moderately rapid, and the available water capacity is moderate. Natural fertility is medium, and organic matter content is moderately low. The soil is medium acid to neutral. The

intake rate is moderately high. Runoff is slow. This soil is easily tilled throughout a wide range of moisture content.

The acreage of this soil is used about equally for cultivated crops and for native grass that is used as rangeland.

Under dryland farming, this soil is suited to corn, alfalfa, soybeans, small grains, and introduced grasses. Soil blowing can be reduced and moisture conserved by stubble mulch tillage, stripcropping, and using a cropping system that keeps the soil covered most of the time with grass or crop residue. A cropping system that includes legumes, grasses, or a mixture of both helps to increase the organic matter content, maintain fertility, and control soil blowing. Row crops can be alternated with small grains and legumes.

Under irrigation, this soil is suited to corn, alfalfa, soybeans, small grains, and introduced grasses. Some land grading is necessary to prepare this soil for gravity irrigation. Sprinkler irrigation is generally the most practical because land leveling is not required. Water applications need to be light and frequent to prevent leaching plant nutrients below the root zone. Returning crop residue to the soil and keeping tillage to a minimum with conservation tillage practices, such as chiseling, discing, or till planting, help to control erosion and maintain fertility. Cover crops or crop residue left on the surface in winter helps to control soil blowing. Adding barnyard manure to the soil increases the organic matter content and improves fertility.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock or improper timing of haying reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition. Livestock distribution can be improved by proper placement of fences, salt facilities, and livestock water.

This soil is suited to trees and shrubs planted in windbreaks. Only trees and shrubs tolerant of slightly sandy, somewhat droughty conditions are suitable. Insufficient moisture and soil blowing are the principal hazards in establishing trees. Soil blowing can be controlled by maintaining strips of sod or cover crops between the tree rows. Cultivation generally needs to be restricted to the tree row. Irrigation can provide supplemental moisture during dry periods. Weeds and undesirable grasses in the tree rows can be controlled with appropriate herbicides, or the areas can be hoed by hand or rototilled.

This soil is generally suited to use as septic tank absorption fields and as sites for dwellings and small commercial buildings. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Providing good surface drainage reduces damage to roads and streets by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This Anselmo soil is in capability units IIe-3 dryland and IIe-8 irrigated. It is in the Sandy range site and windbreak suitability group 5.

AnC—Anselmo fine sandy loam, 2 to 6 percent slopes. This deep, gently sloping, well drained soil is on uplands. Individual areas range from 5 to 200 acres.

Typically, the surface layer is grayish brown, very friable fine sandy loam about 6 inches thick. The subsurface layer is dark grayish brown fine sandy loam about 4 inches thick. The subsoil is brown, very friable fine sandy loam about 14 inches thick. The underlying material is light yellowish brown, loamy fine sand to a depth of more than 60 inches. In places, the surface layer is loamy sand or loam. In places, the dark surface soil is more than 20 inches thick. Some areas have strata of loamy material in the profile at a depth of less than 60 inches. In places, erosion by wind and water has been severe, and the brown subsoil or sandy underlying material is at the surface.

Included with this soil in mapping are small areas of Dunday, O'Neill, and Paka soils. Dunday soils are sandier throughout and are on similar landscape positions. O'Neill soils are on similar landscape positions and have gravelly coarse sand below a depth of 20 inches. Paka soils have a silty subsoil and commonly are lower on the landscape than other areas of this map unit. Included soils make up 10 to 20 percent of this map unit.

Permeability of this Anselmo soil is moderately rapid, and the available water capacity is moderate. The organic matter content is moderately low, and natural fertility is medium. The soil is medium acid or slightly acid. The water intake rate is moderately high. Surface runoff is slow or medium. This soil is easily tilled throughout a wide range of moisture content.

Some of the acreage of this soil is in cultivated crops. The rest is in native grass and is used as rangeland.

Under dryland farming, this soil is suited to corn, alfalfa, small grains, and soybeans. Erosion by wind and water is the main hazard. Erosion can be controlled by using stubble mulch tillage and a cropping system that keeps the soil covered with crops or crop residue. A cropping system that includes legumes, grasses, or a mixture of the two helps to increase the organic matter content and maintain fertility. Row crops can be alternated with small grains and legumes.

Under irrigation, this soil is suited to corn, alfalfa, soybeans, small grains, and introduced grasses. Sprinkler irrigation is the most practical method because of the slope. Water applications should be carefully managed to avoid leaching of plant nutrients below the root zone. Returning crop residue to the soil and keeping tillage to a minimum help to control erosion and maintain

fertility. Cover crops or crop residue left on the surface in winter helps to control erosion by wind and water. Adding barnyard manure to the soil increases the organic matter content and improves fertility.

This soil is suited to rangeland. This use is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper timing of haying reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferments from grazing and haying, and a planned grazing system help to maintain or improve the range condition. Livestock distribution can be improved by proper placement of fences and salt and water facilities.

This soil is suited to trees planted in windbreaks if soil blowing is controlled by maintaining strips of sod or other vegetation between the rows. Drought and competition for moisture from grasses and weeds are hazards. Only trees and shrubs that are tolerant of slightly sandy, somewhat droughty conditions are suited. Irrigation can provide supplemental moisture during periods of low rainfall. Weeds and grasses can be controlled by cultivation in the tree rows with conventional equipment.

This soil is generally suited to use as septic tank absorption fields. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Small commercial buildings need to be properly designed to accommodate the slope, or the soil can be graded to an acceptable gradient. Providing good surface drainage reduces damage to roads and streets by frost action. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This Anselmo soil is in capability units IIIe-3 dryland and IIIe-8 irrigated. It is in the Sandy range site and windbreak suitability group 5.

At—Anselmo loam, 0 to 2 percent slopes. This deep, nearly level, well drained soil is on uplands and stream terraces. Individual areas range from 5 to 200 acres.

Typically, the surface layer is dark grayish brown, friable loam about 8 inches thick. The subsurface layer, similar in color and texture, is about 8 inches thick. The subsoil is grayish brown, very friable fine sandy loam about 13 inches thick. The underlying material extends to a depth of more than 60 inches. It is brown loamy fine sand in the upper part and light yellowish brown fine sand in the lower part. In places, the dark surface soil is silt loam. In places, the subsoil is loam. Some areas have loamy material below a depth of 40 inches. In places, the dark surface layer is more than 20 inches thick. In a few places, the surface layer is fine sandy loam.

Included with this soil in mapping are small areas of Dunday, Jansen, and O'Neill soils. Dunday soils are higher on the landscape and are sandier throughout. Jansen and O'Neill soils are on similar landscape positions and have gravelly coarse sand at a depth of 20 to 40 inches. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Anselmo soil is moderately rapid, and the available water capacity is moderate. Natural fertility is medium, and the organic matter content is moderately low. The soil is medium acid to neutral. The water intake rate is moderately high. Surface runoff is slow. The soil is easy to work.

Most of the acreage of this soil is used for cropland and native grass that is grazed by livestock. A few areas are cut for hay.

Under dryland farming, this soil is suited to corn, soybeans, small grains, sorghum, and alfalfa. Wheat and the first cutting of alfalfa are the most dependable crops because they grow and mature in spring, when rainfall is highest. Insufficient seasonal rainfall restricts crop growth in most years. A cropping system that includes good management of the crop residue is needed to protect the surface from soil blowing and to conserve soil moisture. Additions of barnyard manure and fertilizer improve the organic matter content and natural fertility.

Under irrigation, this soil is suited to corn, soybeans, alfalfa, small grains, and introduced grasses. If a gravity irrigation system is used, some land leveling commonly is necessary to ensure uniform distribution of irrigation water. Deep cuts should be avoided in order to prevent exposing the sandy underlying material. Conservation tillage practices, such as discing or till planting, help to keep residue on the soil surface and conserve soil moisture. Barnyard manure, green manure crops, and commercial fertilizer improve organic matter content and increase fertility.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition and keep the soil in good condition.

This soil is suited to trees and shrubs planted in windbreaks. Insufficient seasonal rainfall is the main limitation for planting trees on this soil. Irrigation can provide supplemental moisture during periods of low rainfall. Weeds and grasses can be controlled by cultivation between the rows. Appropriate herbicides can be applied in the row, or the areas can be hoed by hand or rototilled.

This soil is generally suited to use as septic tank absorption fields and as sites for dwellings and small commercial buildings. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Damage to roads and streets by frost action can be reduced by providing good

surface drainage. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This Anselmo soil is in capability units IIc-1 dryland and I-8 irrigated. It is in the Sandy range site and windbreak suitability group 5.

Ax—Anselmo-O'Neill sandy loams, 0 to 2 percent slopes. These well drained, nearly level soils are on stream terraces. The Anselmo soil is deep over sand, and the O'Neill soil is 20 to 40 inches deep to deposits of sand and gravel. About 40 to 50 percent of this complex is Anselmo soil and 35 to 45 percent is O'Neill soil. The two soils are so intricately mixed that it was impractical to separate them in mapping. Individual areas range from 5 to 500 acres.

Typically, the surface layer of the Anselmo soil is dark gray, very friable sandy loam about 7 inches thick. The subsurface layer is grayish brown, very friable sandy loam about 6 inches thick. The subsoil is brown, very friable sandy loam about 14 inches thick. The underlying material is pale brown loamy sand to a depth of more than 60 inches. In places, the surface layer is loam or loamy sand. In a few places, buried loamy layers are below a depth of 40 inches. In a few places, the subsoil is loam or loamy sand.

Typically, the surface layer of the O'Neill soil is grayish brown, very friable sandy loam about 7 inches thick. The subsurface layer is dark grayish brown, very friable sandy loam about 4 inches thick. The subsoil is brown, very friable sandy loam about 14 inches thick. The underlying material extends to a depth of more than 60 inches. It is pale brown coarse sand in the upper part and very pale brown, gravelly coarse sand in the lower part. In places, the surface layer is loam or loamy sand. In a few places, buried loamy layers are between depths of 20 and 40 inches.

Included with these soils in mapping are small areas of Pivot and Jansen soils. Pivot soils are in similar positions on the landscape as the major soils and contain more sand. Jansen soils are in similar positions and have a finer textured subsoil. Included soils make up 5 to 15 percent of the complex.

Permeability of the Anselmo soil is moderately rapid. Permeability of the O'Neill soil is moderately rapid in the solum and very rapid in the underlying material. The Anselmo soil has moderate available water capacity, and the O'Neill soil has low available water capacity. Organic matter content is moderately low and natural fertility is medium in both soils. The water intake rate is moderately high. Runoff is slow. Both soils are medium acid to neutral. The soils are easily worked.

Most of the acreage of this complex is in cropland. Some areas are in native grass and are used as rangeland or hayland.

Under dryland farming, these soils are suited to corn, sorghum, alfalfa, small grains, soybeans, and introduced grasses. Soil blowing is a hazard unless the surface is protected by crops or crop residue. Conservation tillage practices, such as discing, can be used to keep crop residue on the soil surface. This helps to control soil blowing and conserve soil moisture. Adding barnyard manure and returning crop residue to the soil increase the organic matter content and the natural fertility.

Under irrigation, these soils are suited to corn, sorghum, soybeans, alfalfa, and introduced grasses. Sprinkler irrigation is best suited because land leveling is not required; frequent, light applications of water are needed to prevent leaching plant nutrients below the root zone. Soil blowing can be controlled by keeping crop residue on the surface. Discing and till planting are tillage practices that help to maintain crop residue on the surface.

These soils are suited to rangeland, either for grazing or haying. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper height of mowing reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the range condition.

These soils are suited to trees planted in windbreaks. The O'Neill soil is more droughty because of a shallower rooting depth and low available water capacity. The soils of this complex are mixed and cannot be managed separately. Only drought-tolerant trees and shrubs are suited. Insufficient moisture, moisture competition from grasses and weeds, and soil blowing are the principal hazards. Soil blowing can be reduced by maintaining strips of sod between the rows. Moisture competition from grasses and weeds can be controlled by cultivation between the rows with conventional equipment. Weeds in the row can be controlled by rototilling or hoeing or by careful use of herbicides. However, the use of herbicides on the O'Neill soil can cause problems because of leaching. Irrigation can supply additional moisture during periods of insufficient rainfall.

These soils are generally suited to use as septic tank absorption fields and as sites for dwellings and small commercial buildings. However, although the O'Neill soil readily absorbs the effluent from septic tank absorption fields, it does not adequately filter it. This poor filtering capacity can result in pollution of nearby water supplies. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Damage to local roads and streets by frost action can be reduced by providing good surface drainage. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This complex is in capability units IIe-3 dryland and IIe-8 irrigated. It is in the Sandy range site. The Anselmo soil is in windbreak suitability group 5, and the O'Neill soil is in windbreak suitability group 6G.

AxC—Anselmo-O'Neill sandy loams, 2 to 6 percent slopes. These well drained, gently sloping soils are on uplands. Anselmo soils are deep over sand, and O'Neill soils are underlain by gravelly coarse sand at a depth of 20 to 40 inches. About 45 to 55 percent of this complex is Anselmo soil and about 30 to 40 percent is O'Neill soil. These soils are so intricately mixed that it was not practical to separate them in mapping. Individual areas of this complex range from 5 to 400 acres.

Typically, the surface layer of the Anselmo soil is dark grayish brown, very friable sandy loam about 8 inches thick. The subsurface layer, similar to the surface layer in color and texture, is about 4 inches thick. The subsoil is brown, very friable sandy loam about 12 inches thick. The underlying material is pale brown loamy sand and very pale brown sand to a depth of more than 60 inches. In places, the surface layer is loam or loamy fine sand. In places, the subsoil is loamy sand.

Typically, the surface layer of the O'Neill soil is dark gray, very friable sandy loam about 9 inches thick. The subsoil is very friable sandy loam 13 inches thick. It is dark grayish brown in the upper part and brown in the lower part. The underlying material is pale brown, gravelly coarse sand to a depth of more than 60 inches. In places, the surface layer is loam or loamy fine sand.

Included with these soils in mapping are small areas of Jansen, Pivot, and Paka soils. Jansen and Paka soils are lower on the landscape and have a finer textured subsoil. Pivot soils are higher on the landscape and have a sandy transitional layer. Included soils make up 10 to 15 percent of the complex.

Permeability of the Anselmo soil is moderately rapid. Permeability of the O'Neill soil is moderately rapid in the solum and very rapid in the underlying material. The available water capacity is moderate in the Anselmo soil and low in the O'Neill soil. Both soils are moderately low in organic matter content and medium in natural fertility. Both soils are medium acid to neutral. The water intake rate is moderately high. Runoff is slow. These soils are easily worked.

Most of the acreage of this complex is used for cultivated crops. Some areas are in native grass and are used for grazing or hay.

Under dryland farming, these soils are suited to corn, sorghum, small grains, alfalfa, soybeans, and introduced grasses. Soil blowing and water erosion are the main hazards. Stubble mulch tillage and a cropping system that keeps the soil covered with crop residue help to control erosion and conserve soil moisture. Row crops can be alternated with small grains and legumes.

Under irrigation, these soils are suited to corn, sorghum, alfalfa, and introduced grasses. Sprinkler irrigation is the most practical method because water applications need to be light and frequent. Keeping the soil covered with crops or crop residue most of the time reduces soil blowing and water erosion. Returning crop residue to the soil and keeping tillage to a minimum help to control erosion and increase fertility.

This soil is suited to rangeland. This use is effective in controlling soil blowing and water erosion. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and planned grazing systems help to maintain or improve range conditions.

Soils in this complex are suited to trees planted in windbreaks. O'Neill soils are more droughty because of the shallower root zone and low available water capacity. The soils of this complex are mixed and cannot be managed separately. Only trees and shrubs that are drought tolerant are suited. Insufficient moisture, moisture competition from grasses and weeds, and soil blowing are the principal hazards to the establishment of trees. Soil blowing can be controlled by maintaining strips of sod between the rows. Moisture competition from grasses and weeds can be controlled by cultivation between the rows with conventional equipment. Weeds in the row can be controlled by rototilling, hoeing, or careful use of herbicides. The use of herbicides on the O'Neill soil can cause problems because of leaching. Irrigation can supply supplemental moisture during periods of low rainfall.

These soils are generally suited to use as septic tank absorption fields. The O'Neill soil, however, has poor filtering capacity. It readily absorbs effluent, but it does not adequately filter it. The poor filtering capacity can result in pollution of nearby water supplies. Sewage lagoons need to be lined or sealed to prevent seepage. Walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. These soils are generally suited to dwellings. Small commercial buildings need to be properly designed to accommodate the slope, or the soil can be graded to an acceptable gradient. Damage to roads and streets by frost action can be reduced by providing good surface drainage. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This complex is in capability units IIIe-3 dryland and IIIe-8 irrigated. It is in the Sandy range site. The Anselmo soil is in windbreak suitability group 5, and the O'Neill soil is in windbreak suitability group 6G.

Ba—Barney silt loam, channeled. This poorly drained soil is on low flood plains that are frequently flooded. Slopes range from 0 to 2 percent. The soil is shallow to coarse sand. Individual areas range from 5 to 40 acres.

Typically, the surface layer is gray, very friable silt loam about 8 inches thick. It has thin strata of loamy fine sand and sand. The underlying material to a depth of about 60 inches is light gray, mottled, loose fine sand

stratified with fine sandy loam and loamy fine sand in the upper part and white coarse sand stratified with fine sand in the lower part. In places, the surface layer is less than 8 inches thick. In places, the lower layers do not have significant amounts of gravel. In a few places, the underlying material is gray to greenish gray. In a few places, strata of finer textured material and dark buried layers are in the underlying material.

Included with this soil in mapping are small areas of Boel, Inavale, and Marlake soils. Boel soils are on higher bottom land positions and are somewhat poorly drained. Inavale soils are on the highest bottom land positions and are somewhat excessively drained. Marlake soils are on slightly lower positions and are very poorly drained. In places, the surface layer is stratified sand or fine sand. Included soils make up 5 to 15 percent of the map unit.

Permeability in this Barney soil is rapid. The available water capacity is low. The organic matter content is moderate, and natural fertility is medium. Runoff is very slow. The soil is neutral to moderately alkaline. The seasonal high water table ranges from the surface to a depth of about 2 feet in most years.

Most of the acreage of this soil is in native grass and is used for grazing. Since a large part of the map unit is covered with trees and shrubs, it provides good habitat for wildlife.

This soil is unsuited to cultivation because it is too wet. It is suited to rangeland, mostly for grazing. Overgrazing and deposition of sandy material reduce the protective cover and cause deterioration of the native plants. When the soil is wet, overgrazing can cause surface compaction and small mounds. Proper use and timely deferment from grazing help to maintain the native plants in good condition.

This soil is unsuited to windbreaks. Some small areas can be used for recreational, wildlife, and forestation plantings if water-tolerant trees or shrubs are hand planted or other approved special practices are used.

This soil is generally not suited to septic tank absorption fields, sewage lagoons, and buildings sites because of wetness and flooding. A suitable alternate site is needed. Constructing roads on suitable, well compacted fill material and providing adequate side ditches and culverts help to protect roads from flood damage and wetness resulting from the high water table.

This Barney soil is in capability unit VIw-7 dryland, the Wetland range site, and windbreak suitability group 10.

Bb—Bazile silt loam, 0 to 2 percent slopes. This deep, nearly level, well drained soil is on uplands and stream terraces. Individual areas range from 5 to 1,000 acres.

Typically, the surface layer is dark grayish brown, friable silt loam about 6 inches thick. The subsurface layer is grayish brown, friable silt loam about 5 inches thick. The friable subsoil is about 20 inches thick. It is brown silty clay loam in the upper part, yellowish brown silty clay loam in the middle part, and light yellowish brown clay loam in the lower part. The underlying material is very pale brown sand to a depth of more than 60 inches. In a few places, the dark surface soil is more than 20 inches thick. In places, the surface layer is light silty clay loam, loam, or fine sandy loam.

Included with this soil in mapping are small areas of Fillmore, Trent, and Jansen soils. Fillmore soils are in slight depressions. They have more clay in the subsoil and are poorly drained. Trent soils are on slightly lower positions, have a thicker A horizon, and do not have sand within a depth of 40 inches. Jansen soils are in similar positions on the landscape, and the underlying material is gravelly coarse sand. Included soils make up 10 to 20 percent of this map unit.

Permeability of this Bazile soil is moderately slow in the upper part of the profile and rapid in the lower part. The available water capacity is moderate. Natural fertility is medium, and the organic matter content is moderate. The soil is medium acid to mildly alkaline. The water intake rate is moderate. Surface runoff is slow. Tilth is generally good, and the soil is easily tilled.

Most areas of this soil are used for cultivated crops. Some areas are in native grass and are used as rangeland.

Under dryland farming, this soil is suited to small grains, corn, soybeans, and introduced grasses. This soil is suited to alfalfa, but it is droughty. Soil blowing is a hazard when the soil is cultivated. Conservation tillage practices, such as discing or chiseling, that leave all or part of the crop residue on the surface help to prevent soil blowing and conserve soil moisture. Returning crop residue and barnyard manure to the soil helps to maintain and improve the organic matter content and fertility and increase the infiltration of water.

Under irrigation, this soil is suited to corn, alfalfa, soybeans, and introduced grasses. Leaving crop residue on the surface helps to prevent soil blowing. Efficient management of the irrigation water is a concern of management. Both sprinkler and gravity irrigation systems are suited to this soil. If grading is needed for gravity irrigation, care must be taken so as not to expose the sandy underlying material. Applying barnyard manure and crop residue is a good way to improve the water intake rate on areas that have been cut in grading operations.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock or improper timing of haying reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. Limited precipitation is the principal limitation for planting trees on this soil. Supplemental irrigation of the seedlings may be necessary for good survival and

growth. Seedlings generally survive and grow well if competing vegetation is controlled by good site preparation, timely cultivation, or application of herbicides.

This soil is generally suited to use as sites for dwellings and small commercial buildings. However, although this soil readily absorbs the effluent from septic tank absorption fields, it does not adequately filter the effluent. This poor filtering capacity can result in pollution of nearby water supplies. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Roads and streets need to be designed so that the surface pavement is thick enough to compensate for the low strength of the soil. Coarser grained material for subgrade or base material can be used to ensure better performance. Damage to roads and streets by frost action can be reduced by providing good surface drainage. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This Bazile soil is in capability units IIc-1 dryland and I-7 irrigated. It is in the Silty range site and windbreak suitability group 3.

BbC—Bazile silt loam, 2 to 6 percent slopes. This deep, gently sloping, well drained soil is on uplands. Individual areas range from 5 to 500 acres.

Typically, the surface layer is dark grayish brown, friable silt loam about 9 inches thick. The friable subsoil is about 20 inches thick. It is grayish brown silty clay loam in the upper part, pale brown silty clay loam in the middle part, and pale brown loam in the lower part. The underlying material extends to a depth of more than 60 inches. It is very pale brown loamy sand in the upper part and fine sand in the lower part. In a few places, the surface layer is loam, light silty clay loam, or fine sandy loam. In some local areas, erosion has removed all of the surface soil and exposed the silty clay loam subsoil.

Included with this soil in mapping are small areas of Jansen, Paka, and Trent soils. Jansen soils are in similar positions on the landscape and have underlying material of gravelly coarse sand. Paka soils are in lower positions on the landscape and are loamy throughout the profile. Trent soils are in slightly lower positions, have a thicker surface layer, and do not have sand within a depth of 40 inches. In severely eroded areas, the sandy underlying material is exposed at the surface. Included soils make up 10 to 20 percent of the map unit.

Permeability of this Bazile soil is moderately slow in the upper part and rapid in the lower part. The available water capacity is moderate. Natural fertility is medium, and the organic matter content is moderate. The soil is medium acid to mildly alkaline. The water intake rate is moderate. Surface runoff is medium. This soil is easily worked.

Most areas of this soil are used for cultivated crops. Some areas are in native grass and are used as rangeland.

Under dryland farming, this soil is suited to small grains, corn, soybeans, and introduced grasses. Although it is droughty, it is suited to alfalfa. Water erosion and soil blowing are hazards where the surface is not adequately protected by growing crops or crop residue. Farming on the contour and using conservation tillage practices, such as chiseling and discing, that leave all or part of the crop residue on the surface help to prevent water erosion and soil blowing and conserve soil moisture. Returning crop residue and barnyard manure to the soil helps to maintain and improve the organic matter content and fertility and increase the infiltration of water.

Under irrigation, this soil is suited to corn, alfalfa, soybeans, and introduced grasses. Water erosion and soil blowing are the most serious hazards. Farming on the contour and conservation tillage practices, such as discing and till planting, that leave all or part of the crop residue on the surface help to prevent water erosion and soil blowing and conserve soil moisture. Effieient management of the irrigation water is also a concern. Sprinkler irrigation is best suited to this soil because it does not require leveling of the land. Applying barnyard manure and crop residue increases the water intake rate and organic matter content and improves fertility.

This soil is suited to rangeland. This use is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper timing of haying reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferments from haying or grazing, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. Limited precipitation is the principal limitation for planting trees on this soil. Supplemental irrigation of seedlings may be necessary for good survival and growth. Water erosion and soil blowing can also be problems. Leaving plant residue on the surface and using a minimum of cultivation help to reduce water erosion and soil blowing and conserve soil moisture. Competing vegetation can be controlled by good site preparation and the timely application of herbicides. Areas in the row or near small trees can be hoed by hand or rototilled.

This soil readily absorbs effluent from septic tank absorption fields, but it does not adequately filter the effluent. The poor filtering capacity of this soil can result in pollution of nearby water supplies. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. This soil is suited to dwellings. In places, small commercial buildings need to be properly designed to accommodate the slopes, or the soil can be graded to an acceptable gradient. Roads

and streets need to be designed so that the surface pavement and subbase are thick enough to overcome the low strength of the soil. Damage to roads and streets by frost action can be reduced by providing good surface drainage. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This Bazile soil is in capability units IIIe-1 dryland and IIIe-7 irrigated. It is in the Silty range site and windbreak suitability group 3.

Bg—Blownout land-Valentine complex, 6 to 60 percent slopes. This complex is in the sandhills. Blownout land is mostly barren of vegetation and is in bowl-like depressions that have been hollowed out by the wind (fig. 11). The depressions range from 5 to 50 feet or more in depth. Many of the depressions have eroded down to a permanent water table. The Valentine soil is deep and excessively drained. It is in areas between and adjacent to the areas of Blownout land. Individual areas of this complex range from 5 to to 80 acres. The complex is 50 to 80 percent Blownout land and 20 to 50 percent Valentine soil.

The material of Blownout land is light brownish gray to very pale brown, loose fine sand that shifts easily as the wind blows.

Typically, the Valentine soil has a surface layer of grayish brown, loose fine sand about 5 inches thick. The underlying material is pale brown, loose fine sand to a depth of more than 60 inches. In many places, a 2- to 12-inch layer of light brownish gray to very pale brown, loose sand covers the surface layer.

Figure 11.—An area of Blownout land-Valentine complex, 6 to 60 percent slopes. The Valentine soil is vegetated and on the higher lying areas. Left unprotected, wind continues to remove soil material from the area until it erodes down and exposes the water table. These areas need to be shaped, reseeded, mulched, and protected from grazing use until the native grasses become reestablished.

Included in this complex are small, poorly drained and very poorly drained areas of Tryon and Marlake soils in the bottom of blowouts. Included soils make up 5 to 15 percent of the complex in some areas.

Permeability is rapid. The available water capacity, organic matter content, and natural fertility are low. The soil is slightly acid or neutral. Runoff is slow.

Areas of this complex are used as rangeland. The vegetation, which exists only on the Valentine soil, is sparse. This complex is not suitable for cropland.

The areas of Blownout land in this complex need to be stabilized and native grass reestablished. Wind action continually shifts the sand in these areas. Sand deposited in vegetated areas smothers the grass, creating an ever-enlarging area subject to soil blowing. If they are fenced and livestock is kept out, these areas can be mulched and reseeded to native grass. Some of the steep areas may need to be smoothed and shaped before they can be seeded. Overgrazing by livestock after grass is established can cause severe losses by soil blowing. Proper use, deferment from grazing, and fencing to control grazing help to maintain or improve the range condition in areas of this complex after renovation.

This complex is unsuited to trees in windbreaks. In the areas of Blownout land, the sand is loose, and young seedlings suffer from sand blasting or are covered by drifting sand during high winds. The areas of Valentine soil in this complex can be used for recreational, wildlife, and forestation plantings of tolerant trees or shrubs if they are hand planted or other approved special practices are used. Trees planted in the Valentine soils must be protected from the shifting sand from adjacent areas of Blownout land.

This complex is generally not suited to sanitary facilities or building site development because of the steep slopes. A suitable alternate site is needed. Cuts and fills are needed to provide a suitable grade for roads and streets.

This complex is in capability unit VIIe-5 dryland. It is in the Sands range site and windbreak suitability group 10.

Bm—Boel loamy fine sand, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on bottom lands. It occurs on first bottoms or flood plains along the Elkhorn River and other major drainageways. The soil is occasionally flooded, but floodwaters remain for only short periods. Most areas of this soil are long and narrow and range from 5 to 250 acres.

Typically, the surface layer is dark gray, calcareous, very friable loamy fine sand about 11 inches thick. The transitional layer is grayish brown, calcareous, very friable loamy fine sand about 6 inches thick. The underlying material to a depth of more than 60 inches is light brownish gray and white fine sand stratified with thin lenses of loamy fine sand. It has dark yellowish brown and yellow mottles. In a few places near stream channels, 6 to 24 inches of fine sand overwash are on the surface of this soil. In places, the profile lacks stratification. In a few places, the surface layer is less than 10 inches thick.

Included with this Boel soil in mapping are small areas of Barney, Inavale, and Loup soils. Barney and Loup soils are lower on the landscape and are poorly drained or very poorly drained. Inavale soils are on ridges and are excessively drained. Included soils make up 10 to 20 percent of the map unit.

Permeability of this Boel soil is rapid. The available water capacity is low The organic matter content is moderately low, and natural fertility is medium. The soil is neutral to moderately alkaline. The water intake rate is very high. Runoff is very slow. The seasonal high water table ranges from a depth of 1.5 feet in wet years to about 2.5 feet in dry years. It normally recedes to a depth of 4 to 6 feet during midsummer. This soil is easily tilled throughout a wide range of moisture content.

Areas of this soil are in native grass and are used mostly as rangeland. A few small areas are cut for hay.

Under dryland farming, this soil is poorly suited to corn, small grains, and introduced grasses. Flooding can delay spring planting and limit the production of small grains. Alfalfa is suited in areas where the water table is not too high. This soil is difficult to work in the spring because of wetness caused by the high water table. Alfalfa and other close-growing crops eliminate the need for working this soil in spring and protect it against soil blowing when the surface is dry. The hazard of soil blowing can be reduced by stubble mulch tillage and a cropping system that keeps the soil covered with crop residue most of the time. Returning crop residue to the soil and adding barnyard manure increase the organic matter content and improve fertility.

This soil is poorly suited to irrigation. If flooding is controlled, corn and alfalfa are suitable crops under irrigation. Sprinkler irrigation is the most suitable method. Applications of water need to be light and frequent. Excessive irrigation leaches plant nutrients below the root zone. Normally, tiling is not required, but the water table is a concern in wet periods. Wetness can be controlled by the use of open drains or tile drains where suitable outlets are available. Stubble mulch tillage and the use of winter cover crops are needed to control soil blowing.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing or improper timing of haying reduces the protective cover and causes deterioration of the native plants. When the soil is wet, overgrazing can cause surface compaction and small mounds, making it difficult to graze or harvest hay. Proper grazing use, timely deferment from grazing or haying, and restricted use during wet periods help to maintain the native plants in good condition.

This soil is suited to trees planted in windbreaks. Only trees and shrubs that are tolerant of a moderately high water table should be selected. The establishment of seedlings and cultivation between rows can be a problem during wet years. The abundant and persistent herbaceous vegetation that grows in the tree rows is a concern because it competes with the trees. Weeds and undesirable grasses can be controlled by cultivation between the rows with conventional equipment and by timely use of herbicides.

This soil is not suited to septic tank absorption fields and building sites because of flooding. A suitable alternate site is needed. Sewage lagoons need to be lined or sealed to prevent seepage, and they need to be diked as protection from flooding. Sewage lagoons need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal water table. Digging in this soil during dry periods is easier and helps to avoid caving and water problems. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Constructing roads on suitable, well compacted fill material above flood level and providing adequate side ditches and culverts help to protect roads from flood damage.

This soil is in capability units IVw-5 dryland and IVw-11 irrigated. It is in the Subirrigated range site and windbreak suitability group 2S.

Bn—Boel fine sandy loam, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on bottom lands. It occurs along the Elkhorn River and other major drainageways. The soil is subject to occasional flooding, but floodwaters remain for only short periods. Individual areas of this soil are commonly long and narrow and range from 5 to 250 acres.

Typically, the surface layer is dark gray, calcareous, very friable fine sandy loam about 10 inches thick. The subsurface layer is gray, very friable fine sandy loam about 5 inches thick. The transitional layer is grayish brown, very friable loamy sand about 5 inches thick. The underlying material extends to a depth of more than 60 inches. It is light brownish gray fine sand in the upper part and light gray and white coarse sand with yellowish brown mottles in the lower part. The underlying material is stratified with silty clay loam to loamy fine sand. In places, the surface layer is silt loam or loamy fine sand. Dark buried layers are in some profiles. In a few places, there is 6 to 24 inches of sand or gravelly sand overwash on the surface. In a few places, the entire profile lacks stratification.

Included with this soil in mapping are small areas of Inavale and Loup soils. Inavale soils are in slightly higher positions and are better drained. Loup soils are in some of the old stream channels and are poorly drained or very poorly drained. A few small areas affected by alkali are also included. Included soils make up 10 to 20 percent of the map unit.

Permeability of this Boel soil is rapid. The available water capacity is low. The organic matter content is moderately low, and natural fertility is medium. The soil is neutral to moderately alkaline. The water intake rate is very high. Runoff is very slow. The seasonal high water table ranges from a depth of 1.5 feet in wet years to about 2.5 feet in dry years. This soil is easily worked.

Most areas of this soil are in native grass and are used as rangeland or hayland.

Under dryland farming, this soil is suited to corn, small grains, and introduced grasses. Flooding in the spring can delay cultivation and limit the production of small grains. Alfalfa is suited in areas where the water table is not too high. Alfalfa and other close-growing crops eliminate the need for working the soil in the spring. Wetness caused by the high water table generally delays tillage and cultivation early in spring. The hazard of soil blowing can be reduced by stubble mulch tillage and a cropping system that keeps the soil covered with crop residue most of the time.

Under irrigation, this soil is suited to corn, sorghum, and alfalfa. Sprinkler irrigation is the most suitable method of applying irrigation water. Applications of water need to be light and frequent. Excessive irrigation leaches plant nutrients below the root zone. Where suitable outlets are available, drainage ditches or tile drains can be constructed to help control wetness caused by the high water table. Flooding needs to be controlled before this soil can be gravity irrigated. Returning crop residue to the soil increases the organic matter content. Additions of barnyard manure maintain and improve fertility.

This soil is suited to rangeland. This use is very effective in controlling soil blowing. Overgrazing or improper timing of haying reduces the protective cover and causes deterioration of the native plants. When the soil is wet, overgrazing can cause surface compaction and small mounds, making it difficult to graze or harvest hay. Proper grazing use, timely deferment from grazing or haying, and restricted use during very wet periods help to maintain the native plants in good condition.

This soil is suited to trees planted in windbreaks. Only trees and shrubs that are tolerant of a high water table should be selected. In some years, wetness makes it difficult to establish seedlings and to cultivate between rows. The abundant and persistent herbaceous vegetation that grows in the tree row is a concern because it competes with the trees.

This soil is not suited to septic tank absorption fields or as building sites because of flooding. A suitable alternate site is needed. Sewage lagoons need to be lined or sealed to prevent seepage and diked as protection from flooding. Sewage lagoons need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal high

water table. Digging in this soil during dry periods is easier and helps to avoid caving and water problems. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Constructing roads on suitable, well compacted fill material above flood level and providing adequate side ditches and culverts help to protect roads from flood damage.

This Boel soil is in capability units IIIw-6 dryland and IIIw-11 irrigated. It is in the Subirrigated range site and windbreak suitability group 2S.

Bo—Boel silty clay loam, overwash, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on bottom lands along the Niobrara River and its tributaries. It occurs on flood plains and is occasionally flooded, but floodwaters remain for only a short period. Individual areas range from 5 to 100 acres.

Typically, the surface layer is dark grayish brown, friable, calcareous silty clay loam about 8 inches thick. The subsurface layer is dark gray, very friable fine sandy loam about 10 inches thick. It is thinly stratified with finer and coarser material. The underlying material to a depth of more than 60 inches is white fine sand that is stratified with loamy sand. It has yellowish brown mottles. In places, the surface layer is silt loam, clay loam, or silty clay. In places, the underlying material contains strata of gravelly coarse sand. In a few places, a thin layer of sand is on the surface.

Included with this soil in mapping are small areas of Barney and Invavale soils. Barney soils are lower on the landscape and have a higher seasonal water table. Inavale soils are higher on the landscape and are better drained. Included soils make up 5 to 15 percent of this map unit.

Permeability of this Boel soil is rapid. The available water capacity is low. The organic matter content is moderately low, and natural fertility is medium. The soil is neutral to moderately alkaline. The water intake rate is low. The seasonal high water table ranges from a depth of 1.5 feet in wet years to about 2.5 feet in dry years. It normally recedes to a depth of 4 to 6 feet or more late in summer or early in fall, when the streamflow in the nearby streams is lowest. This soil generally does not have good tilth. It puddles if tilled when wet. Surface runoff is slow.

Most areas of this soil are in native grass and are used as rangeland. Only a few small areas that are free of trees are used as cropland. A large acreage of this map unit is covered with trees and shrubs that need to be cleared before the soil can be used as cropland.

Under dryland farming, this soil is suited to corn, sorghum, small grains, soybeans, alfalfa, and introduced grasses. In some years, wetness caused by the water table and flooding can be problems. The loamy and clayey texture makes the surface layer difficult to work. Growing grasses and legumes in the cropping system and adding barnyard manure improve tilth and increase the organic matter content. Dikes or levees can be constructed to protect cropland from flooding, or crops can be selected that grow and mature in seasons when the flooding hazard is lowest.

Under irrigation, this soil is suited to corn, sorghum, soybeans, alfalfa, and introduced grasses. This soil is suited to sprinkler and gravity irrigation systems. The area used for cropland is generally too small for center-pivot systems. Some areas need protection from flooding before gravity systems can be used. This soil has a low water intake rate, and the surface layer puddles if worked when it is too wet. Returning large amounts of crop residue and barnyard manure to this soil increases the organic matter content and improves the water intake rate. This improves tilth and makes the soil easier to work.

This soil is suited to rangeland, either grazing or haying. This use is effective in controlling erosion. Overgrazing by livestock and deposition of silt reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing, and restricted use during wet periods help to maintain the native plants in good condition.

This soil is suited to planting trees and shrubs in windbreaks. Only trees and shrubs that are tolerant of a high water table are suited. Establishment of seedlings and cultivation can be a problem in wet periods. Dikes can be constructed to control flooding. Weeds and undesirable grasses can be controlled by cultivation or timely applications of herbicides.

This soil is not suited to septic tank absorption fields and building sites because of flooding and wetness. A suitable alternate site is needed. Sewage lagoons need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal high water table. Sewage lagoons need to be diked as protection from flooding and lined and sealed to prevent seepage. Digging is easier during dry periods and helps to avoid caving and water problems. The walls of excavations can be temporarily shored to prevent sloughing or caving. Constructing roads on suitable, well compacted fill material and providing adequate side ditches and culverts help to protect roads from flood damage. Damage to roads by frost action can be reduced by providing good surface drainage and using a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This Boel soil is in capability units IIIw-4 dryland and IIIw-3 irrigated. It is in the Subirrigated range site and windbreak suitability group 2S.

Bp—Boel-Inavale complex, channeled. This complex consists of somewhat poorly drained Boel soil and somewhat excessively drained Inavale soil. It is on bottom lands along major drainageways and is dissected

by creekbeds and stream channels that meander across the flood plains. Slope ranges from 0 to 2 percent. Areas of Boel soil are subject to frequent flooding, but the floodwaters remain on the surface for only a short time. The Inavale soil is higher on the landscape and is rarely flooded. Much of the area is covered with trees and shrubs. The complex is about 35 to 60 percent Boel soil and 20 to 40 percent Inavale soil. The two soils are so intricately mixed it was not practical to separate them in mapping. Individual areas are commonly long and narrow and range from 20 to 1,000 acres or more.

Typically, the Boel soil has a surface layer of dark grayish brown, very friable loamy fine sand about 12 inches thick. The transitional layer is grayish brown, loose loamy sand about 8 inches thick. The underlying material to a depth of more than 60 inches is light brownish gray and light gray fine sand. In places, 6 to 24 inches of fine sand that was deposited by floodwaters is on the surface. In a few places, the underlying material is coarse sand or gravelly coarse sand.

Typically, the Inavale soil has a surface layer of grayish brown, loose fine sand about 8 inches thick. The transitional layer is light brownish gray, loose fine sand about 4 inches thick. The underlying material is light gray fine sand to a depth of more than 60 inches. In places, the surface layer is loamy sand. Thin layers of finer and coarser material and dark buried layers are common in the underlying material. In places, a few mottles are below a depth of 40 inches.

Included with these soils in mapping are small areas of Barney, Loup, and Marlake soils and Riverwash. The poorly drained Barney soils and the poorly drained and very poorly drained Loup soils are in lower positions on the landscape and have a higher seasonal water table. The very poorly drained Marlake soils are mostly in old oxbows or channels. During high streamflows, these areas are covered with water. Riverwash consists of small sandbars and sand flats along the existing streams. These areas are channeled and are subject to reworking and shifting when the streams are flowing at high water stage. Included soils make up 15 to 25 percent of the complex.

Permeability is rapid, and the available water capacity is low in both soils. The organic matter content is moderately low, and the natural fertility is medium in the Boel soil. The organic matter content and natural fertility are low in the Inavale soil. The Boel soil ranges from neutral to moderately alkaline, and the Inavale soil is slightly acid or neutral. The seasonal high water table in the Boel soil ranges from a depth of 1.5 feet in wet years to about 2.5 feet in dry years. It recedes to a depth of 5 to 6 feet during extended dry periods. The seasonal high water table in the Inavale soil is below a depth of 6 feet. Runoff is slow.

All of the acreage of this complex is in native grass and is used mainly for grazing and as wildlife habitat. Many areas are covered with trees, shrubs, and weeds. These soils are unsuitable for cultivation. Most areas are managed with adjoining areas of range and are used for whatever grazing they provide.

These soils are suitable for rangeland. This use is effective in controlling wind and water erosion. Overgrazing reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing, and reduced use during very wet periods help to maintain the native plants in good condition. Boggy conditions can develop in some areas if grazed when wet.

Onsite investigation is needed before these soils are used for most engineering purposes. These soils are not suited to septic tank absorption fields or building sites because of flooding. A suitable alternate site is needed. Sewage lagoons need to be lined or sealed to prevent seepage and diked as protection from flooding. Sewage lagoons on the Boel soil need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal water table. Digging in the Boel soil is easier during dry periods and helps to avoid caving and water problems. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving on these soils. Constructing roads on suitable, well compacted fill material above flood level and providing adequate side ditches and culverts help to protect roads from flood damage.

This complex is in capability unit VIw-5 dryland. The Boel soil is in the Subirrigated range site, and the Inavale soil is in the Sandy Lowland range site. This complex is in windbreak suitability group 10.

BsB—Boelus loamy sand, 0 to 3 percent slopes. This deep, nearly level to very gently sloping, well drained soil is on uplands and stream terraces. Individual areas range from 5 to 1,000 acres.

Typically, the surface layer is dark grayish brown, very friable loamy sand about 12 inches thick. The subsurface layer is about 14 inches thick. It is grayish brown, very friable loamy sand in the upper part and loose, brown sand in the lower part. The subsoil is pale brown, friable silty clay loam about 10 inches thick. The underlying material is light yellowish brown silty clay loam to a depth of more than 60 inches. In places, the surface layer is less than 10 inches thick. In places, the surface layer is sandy loam or sand. In some areas, the sandy material ranges from less than 20 inches thick to more than 36 inches thick over the loamy material.

Included with this soil in mapping are small areas of Anselmo, Dunday, Dunn, Pivot, and Valentine soils. Anselmo, Dunday, and Valentine soils are higher on the landscape and do not have the loamy underlying material. Dunn soils are in similar positions on the landscape and are moderately well drained. Pivot soils are lower on the landscape and have underlying material of gravelly coarse sand. Also included are places where

loamy material is exposed at the surface. Included soils make up 10 to 20 percent of the map unit.

Permeability of this Boelus soil is rapid in the upper part and moderate in the loamy underlying material. The available water capacity is high, and the organic matter content is moderately low. Natural fertility is medium. The soil is slightly acid or neutral in the upper part and neutral to moderately alkaline in the loamy underlying material. Runoff is slow. This soil has a high water intake rate for irrigation. This soil is easily tilled when moist or dry.

Most of the acreage of this soil is farmed. The rest is in native grass. A large acreage is irrigated.

Under dryland farming, this soil is suited to corn, small grains, and alfalfa. Small grains and first cutting alfalfa are generally the most dependable crops because they grow and mature in the spring, when rainfall is plentiful. This soil is highly susceptible to soil blowing. A cropping system that keeps the soil covered with crop residue most of the time reduces soil blowing, conserves soil moisture, and helps to maintain the organic matter content and fertility. Adding barnyard manure increases the organic matter content and improves fertility.

Under irrigation, this soil is suited to corn, soybeans, alfalfa, and introduced grasses. Sprinkler irrigation is the method best suited to this soil because light, frequent applications of irrigation water are needed. Returning crop residue to the soil increases the organic matter content. Keeping the soil covered with crops, grass, or crop residue helps to reduce soil blowing and conserve soil moisture.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock or improper timing of haying reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to planting trees and shrubs in windbreaks. Only trees and shrubs that are tolerant of sandy, somewhat droughty conditions are suited. Inadequate moisture and severe soil blowing are the principal hazards in the establishment of trees. Irrigation can provide supplemental moisture during dry periods. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the rows. Weeds compete with the trees for moisture. Weeds and grasses can be controlled by cultivation or by using appropriate herbicides.

This soil is generally suited to use as septic tank absorption fields and to shallow excavations. Sewage lagoons need to be lined or sealed to prevent seepage. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarser grained material for subgrade or base material can be used to ensure better performance.

This Boelus soil is in capability units IIIe-6 dryland and IIIe-10 irrigated. It is in the Sandy range site and windbreak suitability group 5.

BsC—Boelus loamy sand, 3 to 6 percent slopes. This deep, gently sloping, well drained soil is on uplands. It occupies mostly convex side slopes. Individual areas range from 5 to 200 acres.

Typically, the surface layer is dark gray, very friable loamy sand about 5 inches thick. The subsurface layer is about 15 inches thick. It is dark grayish brown, very friable loamy sand in the upper part and grayish brown, loose sand in the lower part. The subsoil is light brownish gray, friable silt loam about 12 inches thick. The underlying material is light gray and white silt loam to a depth of more than 60 inches. Carbonates are at a depth of 44 inches. In places, the surface layer is less than 10 inches thick. In places, the surface layer is sand or sandy loam. In places, the sandy material ranges from less than 20 inches thick to more than 36 inches thick over the loamy material.

Included with this soil in mapping are small areas of Anselmo, Dunday, Pivot, and Valentine soils. Anselmo, Dunday, and Valentine soils do not have loamy underlying material and are higher on the landscape. The Pivot soils are in similar landscape positions and have underlying material that is gravelly coarse sand. In places, loamy material is exposed at the surface. In places, weathered sandstone is in the lower part of the profile. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Boelus soil is rapid in the sandy material and moderate in the loamy material. The available water capacity is high, and the organic matter content is moderately low. Natural fertility is medium. The soil is slightly acid or neutral in the sandy layers and neutral to moderately alkaline in the loamy material. The water intake rate for irrigation is high. Runoff is slow or medium. This soil is easily worked throughout a wide range of moisture content.

Most of the acreage of this soil is farmed. The rest is in native grass.

Under dryland farming, this soil is suited to corn, sorghum, small grains, and alfalfa. Small grains and the first cutting of alfalfa are generally the most dependable crops because they grow and mature in spring, when rainfall is usually highest. This soil is highly susceptible to soil blowing and water erosion. A cropping system that keeps the soil covered with crop residue most of the time reduces soil blowing and water erosion and helps to conserve soil moisture. Adding barnyard manure increases the organic matter content and improves fertility.

Under irrigation, this soil is suited to corn, soybeans, alfalfa, and introduced grasses. Sprinkler irrigation is the method best suited to this soil. Frequent, light applications of irrigation water are needed to avoid leaching plant nutrients below the root zone. Soil blowing and water erosion can be controlled by using a cropping system that keeps the soil covered with close-growing crops, grass, or crop residue. All crop residue should be returned to the soil.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock or improper timing of haying reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain and improve the range condition.

This soil is suited to planting trees and shrubs in windbreaks. Only trees and shrubs that are tolerant of sandy, somewhat droughty conditions are suited. Inadequate moisture and severe soil blowing are the principal hazards in establishing trees. Irrigation can provide supplemental moisture during dry periods. Soil blowing and water erosion can be controlled by maintaining strips of sod or other vegetation between the rows. Weeds that compete with the trees for moisture can be controlled by cultivation or by using appropriate herbicides.

This soil is generally suited to use as septic tank absorption fields and shallow excavations. For sewage lagoons, grading is required to modify the slope and shape the lagoon. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Small commercial buildings need to be properly designed to accommodate the slope, or the soil can be graded to an acceptable gradient. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarser grained material for the subgrade or base material can be used to ensure better performance.

This Boelus soil is in capability units IVe-6 dryland and IIIe-10 irrigated. It is in the Sandy range site and windbreak suitability group 5.

BsD—Boelus loamy sand, 6 to 11 percent slopes. This deep, strongly sloping, well drained soil is on uplands. It occupies upland side slopes and side slopes along drainageways. Individual areas range from 5 to 250 acres.

Typically, the surface layer is grayish brown, very friable loamy sand about 7 inches thick. The subsurface layer is about 13 inches thick. It is dark grayish brown, very friable loamy sand in the upper part and brown, loose sand in the lower part. The subsoil is light yellowish brown, friable silt loam about 10 inches thick. The underlying material is pale yellow silt loam to a depth of 60 inches. In places, the surface layer is sandy loam or sand. In places, the sandy material ranges from less than 20 inches thick to more than 36 inches thick over the loamy material. In a few places, the underlying material is clay loam. Weathered, fine grained sandstone is below a depth of 40 inches in a few places.

Included with this soil in mapping are small areas of Dunday, Pivot, and Valentine soils. Dunday and Valentine soils are higher on the landscape and do not have the loamy material. Pivot soils are on similar positions in the landscape and have gravelly coarse sand between a depth of 20 and 40 inches. Also included are small areas that have gentler slopes. Some places have loamy material exposed at the surface. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Boelus soil is rapid in the upper part of the profile and moderate in the lower part. The available water capacity is high. The organic matter content is moderately low, and natural fertility is medium. The soil is slightly acid or neutral in the upper layers and neutral to moderately alkaline in the loamy underlying material. This soil has a high intake rate, and runoff is medium. It is easily worked.

Most of the acreage of this soil is in native grass and is used for grazing. A small acreage is used for cropland, and some of it is irrigated.

Under dryland farming, this soil is poorly suited to corn, alfalfa, small grains, and introduced grasses. Soil blowing is the main hazard. A cropping system that keeps the soil covered with crops, grass, or crop residue is needed. Row crops need to be limited in the cropping sequence, and maximum use should be made of close growing crops that protect the soil from erosion. Stripcropping and stubble mulch tillage can be used to control soil blowing. Returning crop residue to the soil and using barnyard manure help to increase the organic matter content and improve the natural fertility.

Under irrigation, this soil is poorly suited to corn, alfalfa, and soybeans. Only sprinkler irrigation is suited to this soil. Light, frequent applications of irrigation water are needed. Excessive water leaches fertilizer below the plant roots. Using stubble mulch tillage and returning crop residue to the soil help to control soil blowing, increase the organic matter content, and conserve moisture. Removal of crop residue should be limited, and grazing of the crop residue should be restricted. Adding barnyard manure helps to increase the organic matter content and improve fertility.

This soil is suited to rangeland. This use is effective in controlling soil blowing and water erosion. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. Only trees and shrubs tolerant of sandy, somewhat droughty conditions are suited. Inadequate moisture and severe soil blowing are the principal

hazards in the establishment of trees. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the tree rows. Irrigation can provide supplemental moisture during extended dry periods. Competition from weeds and undesirable grasses can be controlled by cultivation, hoeing by hand, or timely use of herbicides.

If this soil is used for septic tank absorption fields, land shaping and installation of the septic tank absorption field on the contour are generally necessary for proper operation on the steeper slopes. For sewage lagoons, grading is required to modify the slope and shape the lagoon. This soil generally is suited to shallow excavations, but slope can increase the difficulty of digging. Trenching straight down slopes increases the erosion hazard. Trenching across slopes reduces this problem. Dwellings and small commercial buildings need to be properly designed to accommodate the slope, or the soil can be graded to an acceptable gradient. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarser grained material for subgrade or base material can be used to ensure better performance.

This Boelus soil is in capability units IVe-6 dryland and IVe-10 irrigated. It is in the Sandy range site and windbreak suitability group 5.

BtB—Boelus loamy sand, gravelly substratum, 0 to 3 percent slopes. This deep, nearly level to very gently sloping, well drained soil is on uplands. Individual areas range from 5 to 500 acres.

Typically, the surface layer is dark gray, very friable loamy sand about 6 inches thick. The subsurface layer is about 15 inches thick. It is dark grayish brown, very friable loamy sand in the upper part and brown, loose sand in the lower part. The subsoil is friable sandy clay loam about 21 inches thick. It is brown in the upper part and yellowish brown in the lower part. The underlying material is brownish yellow, gravelly coarse sand to a depth of more than 60 inches. In places, the surface layer is less than 10 inches thick. In places, the surface layer is lighter colored than is typical for this soil. Some areas have gravelly coarse sand at a depth of 30 to 40 inches.

Included with this soil in mapping are small areas of Dunday, Pivot, and Valentine soils. Dunday and Valentine soils are higher on the landscape and are sandy throughout. Pivot soils are in similar positions on the landscape and do not have the loamy layer above the gravelly coarse sand. Included soils make up 10 to 15 percent of this map unit.

Permeability of this Boelus soil is rapid in the sandy upper layers, moderate in the loamy layer, and very rapid in the underlying gravelly coarse sand. The available water capacity is low. The organic matter content is moderately low. Natural fertility is medium. The soil is medium acid to neutral. Runoff is very slow. This soil is easily tilled and has a high water intake rate.

A large acreage of this soil is used for cropland. The remaining areas are in native grass and are used for grazing and hayland.

Under dryland farming, this soil is poorly suited to soybeans, small grains, alfalfa, and corn. Soil blowing is a hazard where the surface is not adequately protected by crop residue or growing crops. Conservation tillage practices, such as discing or chiseling, that leave crop residue on the surface help to prevent soil blowing and conserve soil moisture. Returning crop residue and barnyard manure to the soil helps to maintain or improve the organic matter content and natural fertility.

Under irrigation, this soil is suited to corn, soybeans, alfalfa, and introduced grasses. Soil blowing is a hazard where the surface is not adequately protected by growing crops or crop residue. Light, frequent applications of irrigation water are needed. Excess water leaches plant nutrients below the root zone. A cropping system that keeps the soil covered with crop residue, crops, or grass helps to reduce soil blowing. Conservation tillage practices, such as discing and till planting, help to keep crop residue at the surface. Using barnyard manure and returning crop residue to the soil help to maintain or improve the organic matter content and natural fertility and increase the available water capacity.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. Only trees and shrubs that are tolerant of sandy soils and droughty conditions are suited. Drought and soil blowing are the main hazards in establishing seedlings. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the rows. Trees need to be irrigated during very dry periods to ensure good growth and survival. Undesirable grasses and weeds can be controlled by cultivation or by application of the appropriate herbicides.

If this soil is used for septic tank absorption fields, the poor filtering capacity of this soil can result in pollution of nearby water supplies. This soil readily absorbs effluent from septic tank absorption fields, but it does not adequately filter the effluent. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Foundations for buildings need to be strengthened and backfilled with coarse

material to prevent damage by the shrinking and swelling of the soil. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarser grained material for subgrade or base material can be used to ensure better performance.

This Boelus soil is in capability units IVe-6 dryland and IIIe-10 irrigated. It is in the Sandy range site and windbreak suitability group 5.

BuD—Boelus-Meadin complex, 6 to 11 percent slopes. These deep, well drained and excessively drained soils are shallow over gravelly coarse sand. They are strongly sloping and on uplands. This complex occurs on convex side slopes. It is about 45 to 55 percent Boelus soil and about 25 to 35 percent Meadin soil. The Boelus soil is commonly on the mid and lower side slopes. The Meadin soil is on the upper side slopes and shoulders. These soils are so intermixed it was not practical to separate them in mapping. Individual areas range from 10 to 200 acres.

Typically, the Boelus soil has a surface layer of dark gray, very friable loamy sand about 11 inches thick. The subsurface layer is about 15 inches thick. It is dark grayish brown, very friable loamy sand in the upper part and grayish brown, loose sand in the lower part. The subsoil is pale brown, friable sandy clay loam about 10 inches thick. The underlying material is very pale brown sandy clay loam to a depth of more than 60 inches. In places, the surface layer is sandy loam. In places, the underlying material is clay loam or sandy clay. In places, fine sandy loam material is below a depth of 40 inches.

Typically, the Meadin soil has a surface layer of dark grayish brown, very friable sandy loam about 8 inches thick. The transitional layer is brown, loose, gravelly loamy sand about 8 inches thick. The underlying material is yellowish brown and very pale brown, gravelly coarse sand to a depth of more than 60 inches. In places, the surface layer is loamy sand. In places, fine sandy loam is below a depth of 40 inches.

Included with these soils in mapping are areas of Dunday and Valentine soils on mid and lower slopes and small areas of Pivot soils on some of the upper slopes. Dunday and Valentine soils are sandy throughout. Pivot soils have gravelly coarse sand at a depth of 20 to 40 inches. Also included are small areas where the loamy underlying material and weathered sandstone are exposed at the surface. Included soils make up 15 to 20 percent of the complex.

Permeability in the Boelus soil is rapid in the upper part and moderate in the underlying loamy material. Permeability in the Meadin soil is rapid in the upper part and very rapid in the lower part. The available water capacity is high in the Boelus soil and low in the Meadin soil. The Boelus soil is moderately low in organic matter content and medium in natural fertility. The Meadin soil is moderately low in organic matter content and low in natural fertility. The Boelus soil is slightly acid or neutral in the upper part and neutral to moderately alkaline in the loamy underlying material. The Meadin soil is slightly acid or neutral throughout the profile. Runoff is slow or medium. The water intake rate of these soils is high.

Most of the acreage of this complex is in native grass and is used as rangeland. The Meadin soil is unsuitable for dryland crops because it is too droughty.

Under irrigation, these soils are poorly suited to alfalfa and introduced grasses. Sprinkler irrigation is the only suitable method of irrigation because light, frequent irrigations are needed. Soil blowing and water erosion are hazards if these soils are used as cropland. A cropping system that keeps the soil covered with crops, grass, or crop residue most of the time needs to be used. Returning crop residue to the soil and using barnyard manure increase the organic matter content and improve fertility.

These soils are suited to range. This use is effective in controlling soil blowing and water erosion. Overgrazing reduces the vegetative cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve the range condition.

The Boelus soil is suited to trees and shrubs planted in windbreaks. Trees and shrubs that are tolerant of sandy, somewhat droughty conditions are best suited. Trees need to be watered during prolonged dry periods. Soil blowing can be reduced by maintaining strips of sod or other vegetation between the rows. Weeds can be controlled by cultivation and timely use of herbicides. The Meadin soil is unsuited to trees and shrubs in windbreaks because it is too droughty and too gravelly. Trees grow at different rates on soils of this complex, so tree stands are generally not uniform.

Onsite investigation is needed before these soils are used for most engineering uses. Land shaping and installing the septic tank absorption fields on the contour are generally necessary for septic tank operation in the Boelus soil. The Meadin soil is a poor filter. It readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent. This can result in contamination of nearby water supplies. For sewage lagoons, grading is required to modify slope and shape the lagoon. Sewage lagoons need to be lined and sealed if constructed in the Meadin soil. The walls or sides of shallow excavations made in the Meadin soil need to be temporarily shored to prevent sloughing or caving. Dwellings and small commercial buildings need to be properly designed to accommodate slope, or the soil can be graded to an acceptable gradient. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the Boelus soil. Cuts and fills are generally needed to provide a suitable grade for roads and streets. Roads and streets need to be designed so that the surface pavement and subbase are

thick enough to compensate for the low strength of the Boelus soil. Coarser grained material for subgrade or base material can be used to ensure better performance.

This complex is in capability units VIe-6 dryland and IVe-10 irrigated. The Boelus soil is in the Sandy range site and windbreak suitability group 5. The Meadin soil is in the Shallow to Gravel range site and windbreak suitability group 10.

BwG—Bristow silty clay, 20 to 40 percent slopes. This steep and very steep, well drained soil is on side slopes along drainageways. It is shallow over light colored, soft shale. Individual areas range from 20 to 200 acres.

Typically, the surface layer is pale brown, friable, calcareous silty clay about 6 inches thick. The underlying material, about 10 inches thick, is very pale brown, calcareous shaly clay. Pale yellow, calcareous bedded shale is at a depth of about 16 inches. In places, bedded shale crops out at the surface.

Included with this soil in mapping are small areas of Labu, Lynch, and Sansarc soils. Labu and Sansarc soils formed in darker shales on slopes higher on the landscape. Lynch soils are on lower slopes and have shale below a depth of 20 inches. Included soils make up 10 to 15 percent of this map unit.

Permeability of this Bristow soil is slow. The available water capacity is very low. The organic matter content is moderately low, and natural fertility is low. The soil is mildly aklaline or moderately alkaline. Runoff is very rapid.

All of the acreage of this soil is in native grass and is used as rangeland.

This soil is unsuited to use as cropland because it is too steep and erosive.

This soil is suited to use as rangeland. This use is effective in controlling water erosion. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve the range condition. In places, brush management is needed to control undesirable woody plants on the steeper slopes.

This soil is not suited to planting trees in windbreaks. The steep slopes prevent the use of conventional equipment. Onsite investigations may locate small areas that can be used for recreational or wildlife plantings of tolerant trees or shrubs if they are hand planted.

This soil generally is not suitable for septic tank absorption fields and sewage lagoons because of the steep and very steep slopes and the shallow depth to bedrock. A suitable alternate site is needed. Roads need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarse grained material for subgrade or base material can be used to ensure better performance. Cuts and fills are generally needed to provide a suitable grade for roads. The base material for roads can be mixed with additives, such as hydrated lime, to help prevent shrinking and swelling.

This Bristow soil is in capability unit VIIe-4 dryland. It is in the Shallow Limy range site and windbreak suitability group 10.

BxF—Brunswick-Pivot complex, 9 to 30 percent slopes. These strongly sloping to steep soils are on side slopes along flowing streams and drainageways. The well drained Brunswick soil is moderately deep over weakly cemented sandstone, and the somewhat excessively drained Pivot soil is moderately deep over gravelly coarse sand. About 40 to 50 percent of this complex is Brunswick soil, and about 30 to 40 percent is Pivot soil. The proportions vary from one mapped area to another. Individual areas range from 10 to 1,000 acres.

Typically, the surface layer of the Brunswick soil is grayish brown, very friable fine sandy loam about 5 inches thick. The subsoil is very friable fine sandy loam about 16 inches thick. It is brown in the upper part and pale brown in the lower part. The underlying material, about 13 inches thick, is light gray loamy fine sand. White, soft, fine grained sandstone is at a depth of about 34 inches. In places, the surface layer is loamy sand or silt loam. In places, the subsoil is sandy clay loam, silt loam, or loamy fine sand. In some areas, part or all of the profile is calcareous. In places, the underlying bedrock is calcareous.

Typically, the surface layer of the Pivot soil is dark grayish brown, very friable loamy sand about 10 inches thick. The transitional layer is grayish brown, very friable loamy sand about 6 inches thick. The underlying material is brown loamy coarse sand to a depth of 24 inches. Light yellowish brown, gravelly coarse sand extends to a depth of more than 60 inches. In places, the surface layer is fine sandy loam. In places, the surface layer is more than 20 inches thick. In places, the underlying material is coarse sand or sand to a depth of 60 inches.

Included in this complex are small areas of Anselmo, Meadin, O'Neill, and Paka soils. Anselmo, O'Neill, and Paka soils are on lower side slopes. Anselmo soils do not have the underlying sandstone. O'Neill soils have gravelly coarse sand at a depth of 20 to 40 inches. Paka soils are finer textured. Meadin soils are on narrow ridges and steep shoulders or side slopes. Meadin soils have gravelly coarse sand at a depth of 8 to 20 inches. Included soils make up 15 to 25 percent of the complex.

Permeability in the Brunswick soil is moderately rapid. In the Pivot soil, permeability is rapid in the upper part and very rapid in the gravelly coarse sand. The available water capacity is low in both soils. The organic matter content is low in the Brunswick soil and moderately low in the Pivot soil. The natural fertility of both soils is medium. Both soils are medium acid to neutral. Surface runoff is rapid.

Nearly all of the acreage of this complex is in native grass and is used as rangeland.

These soils are unsuited to cropland because of the steep slopes. Water erosion and soil blowing are severe hazards if the surface is not protected by grass.

These soils are suited to rangeland. This use is effective in controlling soil blowing and water erosion. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. Proper grazing use, deferred grazing, or a planned grazing system helps to maintain or improve the range condition.

These soils are unsuited to trees and shrubs planted in windbreaks. The steep slopes prevent the use of conventional equipment. Some areas can be used for recreational, wildlife, and forestation plantings of tolerant trees and shrubs if they are planted by hand or other approved special practices are used.

These soils generally are not suitable for sanitary facilities because of the steep slopes. A suitable alternate site is needed. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. The slope increases the difficulty of digging. If a trench goes straight down the slope, the erosion hazard increases. Trenching across the slope can decrease the problem. Rock can make digging difficult. Alternate routing with less rock can be selected. These soils generally need cuts and fills to provide a suitable grade for roads.

This complex is in capability unit VIe-1 dryland. It is in Sandy range site and windbreak suitability group 10.

ByF—Brunswick-Tassel fine sandy loams, 11 to 40 percent slopes. These moderately steep to very steep soils are on side slopes along drainageways. This complex is about 50 to 60 percent Brunswick soil and 20 to 30 percent Tassel soil. Ledges of quartzite and sandstone bedrock crop out in areas of this complex. The well drained Brunswick soil is generally on the smooth lower side slopes and is moderately deep over soft sandstone. The well drained Tassel soil is on upper side slopes and is shallow to soft sandstone. The soils are so intricately mixed that it was not practical to separate them in mapping. Individual areas range from 20 to more than 1,000 acres.

Typically, the Brunswick soil has a dark grayish brown, very friable fine sandy loam surface layer about 4 inches thick. The subsoil is very friable fine sandy loam about 12 inches thick. The upper part is grayish brown and the lower part is light brownish gray. The underlying material, about 8 inches thick, is light gray loamy fine sand. White, soft sandstone is at a depth of about 24 inches. In places, the surface layer is silt loam. In places, the subsoil is sandy clay loam or silt loam. In places, the soft sandstone is below a depth of 40 inches. In a few places, the profile contains carbonates. In some places, the sandstone is calcareous.

Typically, the Tassel soil has a light brownish gray, very friable, calcareous, fine sandy loam surface layer about 5 inches thick. The underlying material, about 9 inches thick, is light gray, calcareous fine sandy loam. Light gray, calcareous soft sandstone is at a depth of about 14 inches. In places, the surface layer is silt loam or loam. In places, the underlying material is loam or sandy clay loam. In places, the surface layer is darker.

Included in this complex are small areas of Inavale, O'Neill, Paka, and Labu soils. Inavale soils are on the bottom lands along drainageways and are sandy throughout. O'Neill and Paka soils are in similar positions on the landscape as Brunswick soils. O'Neill soils are underlain by gravelly coarse sand. Small areas of Rock outcrop are mapped as inclusions in this complex. Included soils make up 15 to 20 percent of the complex.

Permeability of these Brunswick and Tassel soils is moderately rapid. The available water capacity is low in the Brunswick soil and very low in the Tassel soil. Both soils have low organic matter content. Natural fertility is medium in the Brunswick soil and low in the Tassel soil. Surface runoff is rapid. The Brunswick soil is medium acid to neutral. The Tassel soil is mildly alkaline or moderately alkaline.

Nearly all of this complex is in native grass and is used as rangeland.

These soils are not suited to cultivation. The slopes are too steep, and the soils are too droughty for cultivation. Water erosion is a severe hazard if these soils are cultivated or overgrazed.

These soils are suited to rangeland. This use is very effective in controlling soil blowing and water erosion. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve the condition of the range.

These soils are generally unsuited to trees planted in windbreaks, but onsite investigation can locate small areas suitable for planting. The soils are too steep and too droughty for good survival and growth of trees and shrubs. Some areas can be used for recreation or wildlife plantings of tolerant trees or shrubs if they are planted by hand or other approved special practices are used.

These soils generally are not suitable for sanitary facilities because of the steep slope and shallow depth to bedrock. A suitable alternate site is needed. Cuts and fills are generally needed to provide a suitable grade for roads.

This complex is in capability unit VIs-4 dryland. The Brunswick soil is in the Sandy range site, and the Tassel soil is in the Shallow Limy range site. Both soils are in windbreak suitability group 10.

Ce—Cass fine sandy loam, 0 to 2 percent slopes. This deep, nearly level, well drained soil is on high

bottom lands that are rarely flooded. Individual areas range from 5 to 1,200 acres.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 5 inches thick. The subsurface layer is dark gray, very friable fine sandy loam about 13 inches thick. The transitional layer is about 12 inches thick. It is grayish brown, very friable fine sandy loam that has thin strata of loamy fine sand. The underlying material extends to a depth of more than 60 inches. It is light brownish gray loamy fine sand stratified with fine sandy loam in the upper part and very pale brown fine sand in the lower part. In places, the dark surface soil is more than 20 inches thick. In places, the surface layer is loam or loamy sand. In some areas, gravelly coarse sand is below a depth of 40 inches. Mottles are in some profiles below a depth of 40 inches.

Included with this soil in mapping are small areas of Dunday, Inavale, and Ord soils. Dunday and Inavale soils are higher on the landscape and contain more sand. Ord soils are lower on the landscape and are somewhat poorly drained. Included soils make up 10 to 15 percent of the map unit.

Permeability is moderately rapid in the solum and rapid in the underlying material. The available water capacity is moderate. The organic matter content is moderately low. Natural fertility is medium. The soil is medium acid to neutral in the upper part and slightly acid to mildly alkaline in the lower part. This soil can be tilled throughout a wide range of moisture content. The water intake rate for irrigation is moderately high. Runoff is slow.

Most of the acreage of this soil is farmed, and some of it is irrigated. The remaining acreage is in native grass and is used as rangeland or hayland.

Under dryland farming, this soil is suited to corn, alfalfa, small grains, and soybeans. Stubble mulch tillage and a cropping system that keeps the soil covered most of the time with grasses or crop residue are needed to control soil blowing. Row crops can be alternated with small grains and legumes. Returning crop residue to the soil and adding barnyard manure to the soil help to increase the organic matter content and improve fertility.

Under irrigation, this soil is suited to corn, soybeans, alfalfa, small grains, and introduced grasses. Some land grading is needed to prepare this soil for gravity irrigation. Sprinkler irrigation is suited. Returning crop residue to the soil and keeping tillage to a minimum help to control soil blowing and maintain fertility. Crop residue left on the surface during winter helps control soil blowing. Heavy additions of barnyard manure increase the organic matter content and improve fertility.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock and improper timing of haying reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to planting trees and shrubs in windbreaks. Only trees and shrubs that are tolerant of slightly sandy, somewhat droughty conditions are suited. Inadequate moisture and soil blowing are the main hazards in establishing trees. Strips of sod or a cover crop between the rows reduces soil blowing. Irrigation can provide supplemental water during dry periods. Weeds and undesirable grasses can be controlled by cultivating with conventional equipment or by timely use of herbicides. Areas near the trees can be rototilled or hoed by hand.

This soil readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent. This poor filtering capacity can result in pollution of the underground water table. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Dwellings and buildings can be constructed on elevated, well compacted fill material as protection against flooding. Constructing roads on suitable, well compacted fill material above flood level and providing adequate side ditches and culverts help to protect roads from flood damage. Damage to roads and streets by frost action can be reduced by providing good surface drainage. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This soil is in capability units IIe-3 dryland and IIe-8 irrigated. It is in the Sandy Lowland range site and windbreak suitability group 1.

DuB—Dunday loamy sand, 0 to 3 percent slopes. This deep, nearly level to very gently sloping, somewhat excessively drained soil is on uplands and stream terraces. Individual areas range from 5 to 1,000 acres or more.

Typically, the surface layer is dark gray, very friable loamy sand about 7 inches thick. The subsurface layer is dark grayish brown, very friable loamy sand about 10 inches thick. The transitional layer is brown, very friable sand about 11 inches thick. The underlying material is pale brown and very pale brown fine sand to a depth of more than 60 inches. In places, the upper part of the surface layer is sand or fine sand. In places, the dark surface soil is more than 20 inches thick. Some areas have fine gravel scattered throughout the profile. In a few places, loamy material is below a depth of 40 inches.

Included with this soil in mapping are small areas of Boelus, Dunn, Pivot, and Valentine soils. Boelus, Dunn, and Pivot soils are in similar positions on the landscape. Boelus and Dunn soils have loamy underlying material, and Pivot soils have gravelly coarse sand at a depth of 20 to 40 inches. Valentine soils are on higher positions on the landscape and have a thinner surface layer. Small

areas with steeper slopes are included. Included soils make up 10 to 20 percent of this map unit.

Permeability of this Dunday soil is rapid. The available water capacity is low. The organic matter content is moderately low. Natural fertility is low. The water intake rate is very high. Runoff is slow. The soil is slightly acid or neutral. This soil is easily worked throughout a wide range of moisture content.

A large acreage of this soil is farmed, and much of it is irrigated. The remaining areas are in native grass and are used as rangeland.

Under dryland farming, this soil is poorly suited to corn, sorghum, alfalfa, small grains, and introduced grasses. Soil blowing is a serious hazard. Returning crop residue to the soil and using barnyard manure help to increase the organic matter content and improve fertility. Planting rye or rye and vetch between corn rows in the fall provides winter pasture and a winter cover crop to reduce soil blowing. Stripcropping can also be used to control soil blowing. The low available water capacity makes this soil droughty.

Under irrigation, this soil is suited to corn, soybeans, alfalfa, and introduced grasses. Sprinkler irrigation is the only method suited to this soil. Applications of water should be light and frequent to prevent leaching of plant nutrients below the root zone. Soil blowing is a severe hazard in cultivated areas. A cropping system that keeps the soil covered with crops, grass, or crop residue helps to reduce soil blowing and conserve moisture. All crop residue should be returned to the soil.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock reduces the productive cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing, and control of weeds are needed to maintain or improve range condition. More nearly uniform grazing can be obtained by proper placement of fences and salt and water facilities.

This soil is suited to trees and shrubs planted in windbreaks. Only trees and shrubs that are tolerant of sandy, somewhat droughty conditions are suited. Inadequate moisture and severe soil blowing are the principal limitations in the establishment of trees. Irrigation can provide moisture during dry periods. Soil blowing can be prevented by maintaining strips of sod or other vegetation between the rows. Weeds and undesirable grasses can be controlled by cultivating with conventional equipment or by herbicides.

This soil is generally suited to use as sites for dwellings, small commercial buildings, roads, and streets. When this soil is used for septic tank absorption fields, the poor filtering capacity can result in pollution of nearby water supplies. It readily absorbs effluent from septic tank absorption fields, but it does not adequately filter the effluent. Sewage lagoons need to be lined and sealed to prevent seepage. The walls of excavations can be temporarily shored to prevent sloughing or caving.

This Dunday soil is in capability units IVe-5 dryland and IIIe-11 irrigated. It is in the Sandy range site and windbreak suitability group 5.

DuC—Dunday loamy sand, 3 to 6 percent slopes. This deep, gently sloping, somewhat excessively drained soil is on uplands. Individual areas range from 5 to 1,000 acres.

Typically, the surface layer is dark gray, very friable loamy sand about 6 inches thick. The subsurface layer is dark grayish brown, very friable loamy sand about 6 inches thick. The transitional layer is brown, loose fine sand about 8 inches thick. The underlying material is light gray fine sand to a depth of more than 60 inches. In places, the upper part of the surface layer is sand or fine sand. In places, the dark surface soil is more than 20 inches thick. In cultivated areas, the ridgetops and knolls are eroded and are lighter colored than the surrounding soils.

Included with this soil in mapping are small areas of Anselmo, Boelus, Pivot, and Valentine soils. Anselmo soils are finer textured and are lower on the landscape. Boelus soils are lower on the landscape and have loamy underlying material. Pivot soils occupy similar positions on the landscape and have gravelly coarse sand below a depth of 20 inches. Valentine soils are higher on the landscape and have a thinner surface layer. Included soils make up 10 to 20 percent of the map unit.

Permeability of this Dunday soil is rapid, and the available water capacity is low. The organic matter content is moderately low. Natural fertility is low. The soil is slightly acid or neutral. The water intake rate is very high, and runoff is slow. This soil is easily worked.

A large acreage of this soil is used as farmland, and some of it is irrigated. The remaining acreage is in native grass.

Under dryland farming, this soil is poorly suited to corn, soybeans, small grains, alfalfa, and introduced grasses. Small grains and first cutting alfalfa are generally the better suited crops because they grow and mature in the spring when rainfall is highest. Starting crops is sometimes difficult because soil blowing destroys small plants early in spring. Soil blowing can be reduced, moisture conserved, and the organic matter and natural fertility maintained by using a cropping system that keeps the soil covered with crops or crop residue. Row crops need to be limited in the cropping sequence, and maximum use needs to be made of close growing crops to protect the soil. Stripcropping and field windbreaks can be used to control soil blowing. Returning crop residue to the soil and using barnyard manure increase the organic matter content and improve fertility.

Under irrigation, this soil is suited to corn, sorghum, alfalfa, small grains, and introduced grasses. Sprinkler irrigation is best suited because this soil requires light, frequent irrigation to avoid excessive leaching of plant

nutrients. Soil blowing can be controlled and the organic matter content increased by using a stubble mulch system of tillage, returning crop residue to the soil, using winter cover crops, and planting close growing crops.

This soil is suited to rangeland. This use is effective in controlling soil blowing and water erosion. Overgrazing by livestock or improper haying time reduces the protective cover and causes deterioration of the native plants. It also can cause severe losses by soil blowing. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve range conditions.

This soil is suited to planting trees and shrubs in windbreaks. Capability for survival and growth of adapted species is fair. Only trees and shrubs that are tolerant of sandy, droughty conditions are suited. Insufficient moisture, competition from grasses and weeds, and soil blowing are the main problems. Irrigation can provide supplemental water during periods of low rainfall. Weeds and grasses can be controlled by the timely use of herbicides or by cultivation. Cultivation needs to be restricted to the tree rows. Areas between the trees can be rototilled or hoed by hand. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the rows.

This soil is generally suited to use as sites for dwellings and roads and streets. This soil readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent. This poor filtering capacity can result in pollution of nearby water supplies. Sewage lagoons need to be lined and sealed to prevent seepage. The walls of excavations can be temporarily shored to prevent sloughing or caving. Small commercial buildings need to be properly designed to accommodate the slope, or the soil can be graded to an acceptable gradient.

This Dunday soil is in capability units IVe-5 dryland and IVe-11 irrigated. It is in the Sandy range site and windbreak suitability group 5.

DxB—Dunn loamy sand, 0 to 3 percent slopes. This deep, nearly level to very gently sloping, moderately well drained soil is on the uplands and stream terraces. Areas range from 5 to 1,000 acres or more.

Typically, the surface layer is dark grayish brown, very friable loamy sand about 12 inches thick. The transitional layer is grayish brown, very friable sand about 5 inches thick. The underlying material is pale brown sand about 11 inches thick. It has yellowish brown mottles. At 28 inches is a layer of light brownish gray sandy clay loam about 14 inches thick. Below this is light gray sandy clay loam to a depth of more than 60 inches. It has brownish yellow mottles. In places, the surface layer is sandy loam or sand. In a few places, the loamy material is calcareous. In some places, coarse sand or gravelly coarse sand is below a depth of 40 inches.

Included with this soil in mapping are small areas of Boelus, Dunday, O'Neill, Pivot, and Valentine soils. Boelus, O'Neill, and Pivot soils are in similar landscape positions. Boelus soils are well drained. O'Neill and Pivot soils have gravelly coarse sand at a depth of 20 to 40 inches. Dunday and Valentine soils are higher on the landscape and are sandy throughout the profile. Also included are small areas where the loamy material is exposed at the surface. Included soils make up 10 to 20 percent of this map unit.

Permeability of this Dunn soil is rapid in the sandy upper part and slow in the loamy lower part. The available water capacity is moderate. The organic matter content is moderately low, and natural fertility is low. The soil is medium acid to neutral in the sandy upper part and medium acid to mildly alkaline in the loamy underlying material. The water intake rate is high, and runoff is slow. Water is ponded in some of the swales and low areas during wet periods for a short time. In the spring or during wet periods, a water table is perched for a short time above the finer textured underlying material.

Most of the acreage of this soil is farmed. A large acreage of the cropland is irrigated. The rest is in native grass and is used for grazing or hay.

Under dryland management, this soil is poorly suited to corn, alfalfa, small grains, sorghum, and grasses. Small grains and the first cutting of alfalfa are generally the most dependable crops because they grow and mature in spring when rainfall is plentiful. Controlling soil blowing and conserving soil moisture are the main problems. Wetness can be a problem in low areas. Returning crop residue to the soil and using barnyard manure help to increase the organic matter content and improve fertility. Stripcropping and close-growing crops can be used to control soil blowing.

Under irrigation, this soil is suited to corn, soybeans, alfalfa, and introduced grasses. Sprinkler irrigation is the only method suited to this soil. The soil is too sandy for gravity irrigation. Light, frequent applications of irrigation water are needed. Excessive water leaches fertilizers below the plant roots. This soil is highly susceptible to soil blowing, and wetness can be a problem in low areas (fig. 12). A cropping system that keeps the soil covered with crop residue most of the time reduces soil blowing, conserves moisture, and helps to maintain the organic matter content and fertility. Low areas and swales may need to be artificially drained to eliminate wetness problems.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. Only trees and shrubs tolerant of sandy,

Figure 12.—An area of Dunn loamy sand, 0 to 3 percent slopes. Water that is perched above the slowly permeable, loamy underlying material ponds for short periods in some of the low areas and swales.

somewhat droughty conditions are suited. Insufficient moisture and soil blowing are the main problems in the establishment of trees. Irrigation can provide supplemental moisture during dry periods. Soil blowing can be prevented by maintaining strips of sod or other vegetation between the rows. Weeds and undesirable grasses that compete with the trees can be controlled by cultivation or timely applications of herbicides.

Septic tank absorption fields are not suited to this soil because of slow permeability. A suitable alternate site is needed. Sewage lagoons need to be lined or sealed to prevent seepage. In places, they need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above a perched water table. Walls or sides of shallow excavations can be shored to prevent sloughing or caving. Digging during dry periods helps to avoid wetness problems. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. In places, buildings and dwellings need to be constructed on raised, well compacted fill material to overcome wetness caused by a perched water table. Constructing roads on suitable, well compacted fill material and providing adequate side ditches and culverts help to protect roads from wetness. Damage to roads by frost action can be reduced by providing good surface drainage and by use of a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This Dunn soil is in capability units IVe-6 dryland and IIIe-10 irrigated. It is in the Sandy Lowland range site and windbreak suitability group 5.

Eb—Els loamy sand, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on bottoms of valleys and in low areas of sandhills. Flooding is rare. Individual areas range from 5 to 1,000 acres or more.

Typically, the surface layer is dark gray, very friable loamy sand about 6 inches thick. The transitional layer is grayish brown, loose fine sand about 7 inches thick. The underlying material extends to a depth of 60 inches or more. It is brown, very pale brown, and white, mottled sand in the upper part and white coarse sand in the lower part. In places, the surface layer is more than 9 inches thick. In places, the surface layer is fine sand. In places, loamy strata are below a depth of 40 inches.

Included with this soil in mapping are small areas of Ipage and Tryon soils. Ipage soils are on higher ridges and are moderately well drained. Tryon soils occupy the low areas and drainageways and are poorly drained and

very poorly drained. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Els soil is rapid, and the available water capacity is low. The organic matter content is moderately low, and natural fertility is low. The soil is slightly acid to mildly alkaline. Runoff is very slow. The water intake rate is very high. The seasonal high water table ranges from a depth of about 1.5 feet in wet years to about 2.5 feet in dry years.

Most of the acreage of this soil is in native grass and is used as hayland or range. A small acreage is used for cropland, and most of the cropland is irrigated.

Under dryland farming, this soil is poorly suited to corn, soybeans, and alfalfa. Production of small grains is limited because the water table is highest in the spring. Soil wetness delays planting in spring and may prevent cultivation during the wettest season. During dry parts of the year, the water table can be beneficial to grasses and growing crops. The water table can drown out alfalfa in some places. Soil blowing is a hazard where this soil is cultivated. Soil blowing can be controlled by using a stubble mulching system of tillage, returning crop residue to the soil, planting winter cover crops, and using close-grown crops. Barnyard manure is needed on this soil to increase the organic matter content and improve fertility.

Under irrigation, this soil is poorly suited to corn, soybeans, alfalfa, and introduced grasses. Sprinkler irrigation is the most suitable method on this soil. Irrigation water needs to be applied frequently in small quantities to prevent waterlogging and deep leaching of plant nutrients. Tiling is normally not required for irrigation, but the water table is a problem during wet periods. Soil blowing can be controlled by using a stubble mulch system, using crop residue, and planting close-growing crops.

This soil is suited to native grass. The use of this soil for rangeland, either grazing or haying, is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. In addition, when the soil is wet, overgrazing can cause compaction and small mounds, making it difficult to graze or harvest for hay. Proper grazing use, timely deferment from grazing or haying, and restricted use during wet periods help to maintain the native plants in good condition.

When this soil is used for hayland, mowing needs to be regulated so that the grasses remain vigorous and keep their place in the meadow. In order to allow for carbohydrate storage in the grass plants, mowing should be avoided between boot stage and seed maturity, especially on meadows that are hayed about the same time each year. The meadow should be mowed before the dominant grasses reach the boot stage. Additions of nitrogen and phosphate fertilizers can increase hay production (*4*). After frost, range animals can usually graze the meadows without damage if the areas are properly stocked.

This soil is suitable for trees and shrubs planted in windbreaks if the species can tolerate occasional wetness. Establishing the trees and cultivating between the rows can be a problem in wet seasons. The soil should be tilled and trees planted after the soil dries out. The abundant and persistent herbaceous vegetation that grows in the tree rows is a concern because it competes with the trees. Weeds and grasses can be controlled by cultivation or by using appropriate herbicides.

Septic tank absorption fields can be constructed on fill material so that the absorption field is placed a sufficient distance above the seasonal high water table. This soil readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent. The poor filtering capacity can result in pollution of the underground water table. Sewage lagoons need to be lined or sealed to prevent seepage. Sewage lagoons need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal water table. The walls or sides of shallow excavations can be shored to prevent sloughing or caving. Digging during dry periods helps to reduce water problems. Dwellings and buildings need to be constructed on raised, well compacted fill material to overcome wetness caused by the high water table and as protection from flooding. Constructing roads on suitable, well compacted fill material and providing adequate side ditches and culverts help to protect roads from flood damage and wetness. Damage by frost action can be reduced by providing good surface drainage and by using a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This Els soil is in capability units IVw-5 dryland and IVw-11 irrigated. It is in the Subirrigated range site and windbreak suitability group 2S.

EfB—Els-Ipage complex, 0 to 3 percent slopes. The deep, nearly level Els soil and deep, nearly level to very gently sloping Ipage soil are on bottoms of upland valleys within or adjacent to areas of sandhills. The somewhat poorly drained Els soil is in the swales that rarely flood. The moderately well drained Ipage soil is on low sandy ridges that are not flooded. Individual areas of this complex range from 10 to several thousand acres. The complex is 25 to 65 percent Els soil and from 20 to 60 percent Ipage soil. The two soils are so intricately mixed that it was not practical to separate them in mapping.

Typically, the Els soil has a surface layer of grayish brown, very friable loamy sand about 8 inches thick. The transitional layer is light brownish gray, loose fine sand about 10 inches thick. It has reddish brown mottles. The underlying material to a depth of more than 60 inches is

very pale brown fine sand that has yellowish brown mottles. In places, the surface layer is loamy fine sand or fine sand. In places, the surface layer is 10 inches or more thick. In a few places, loamy material or gravelly coarse sand is below a depth of 40 inches.

Typically, the Ipage soil has a surface layer of dark grayish brown, very friable sand about 5 inches thick. The transitional layer is grayish brown, loose sand about 6 inches thick. The underlying material extends to a depth of more than 60 inches. It is pale brown sand in the upper part, very pale brown and white fine sand in the middle part, and light gray coarse sand in the lower part. Yellowish brown mottles are below a depth of 32 inches. In places, the surface layer is loamy sand or fine sand. In places, gravelly coarse sand is between depths of 20 and 40 inches.

Included with these soils in mapping are small areas of Tryon and Valentine soils. Tryon soils are on lower parts of the landscape and have a higher seasonal water table than the Els soil. Valentine soils are higher on the landscape than the Ipage soil and are excessively drained. Included soils make up 10 to 15 percent of the complex.

Permeability is rapid in both the Els and Ipage soils. Both soils have low available water capacity. The organic matter content is moderately low in the Els soil and low in the Ipage soil. Natural fertility is low in both soils. The Els soil is slightly acid to mildly alkaline, and the Ipage soil is medium acid to neutral. Runoff is slow to very slow. The water intake rate is very high. The seasonal high water table in the Els soil ranges from a depth of about 1.5 feet in wet years to about 2.5 feet in dry years. The seasonal high water table in the Ipage soil ranges from a depth of about 3 feet in wet years to about 6 feet in dry years.

Most of the acreage of this complex is in native grass and is used as range or hayland. The remaining acreage is mostly irrigated cropland.

This complex is unsuited to dryland cultivation because of droughtiness and the hazard of soil blowing on the Ipage soil if the grass cover is removed.

Under irrigation, this complex is suited to corn, soybeans, alfalfa, and introduced grasses. These soils are too sandy for gravity methods of irrigation, but they can be sprinkler irrigated (fig. 13). Soil blowing is a severe hazard where the surface is not adequately

Figure 13.—Irrigated corn on an area of Els-Ipage complex, 0 to 3 percent slopes. The Ipage soil is on the ridges, and the Els soil is in the swales.

protected. Wetness is a problem in some of the low areas, and artificial drainage can be needed. Soil blowing can be controlled by using winter cover crops, using close-growing crops, and leaving crop residue on the surface. Barnyard manure is needed to improve the organic matter content and improve fertility.

This complex is suited to range. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use and timely deferment from grazing or haying help to maintain the native plants in good condition. When the Els soil is wet, overgrazing can cause surface compaction and small mounds, making it difficult to graze or harvest for hay.

Mowing needs to be regulated so that the grasses remain vigorous when these soils are used as hayland. The meadow should be mowed before the dominant grass species reach the boot stage. Mowing should be avoided between boot stage and seed maturity. After frost and during winter, range animals can graze meadows without damage if the areas are properly stocked.

This complex is suited to planting trees in windbreaks if soil blowing is controlled. The species selected for planting on the Els soil should be able to tolerate occasional wetness. Establishment of seedlings can be difficult during wet years. The soil should be tilled and trees planted after the soil dries. The Ipage soil is so loose that trees have to be planted in shallow furrows and not cultivated. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the rows. Young seedlings can suffer from sand blasting during high winds and are sometimes covered by drifting sand. The abundant and persistent herbaceous vegetation that grows on this site can be controlled by cultivation or by appropriate herbicides.

If these soils are used for septic tank absorption fields, care should be taken to be certain that seepage does not contaminate the underground water table. These soils readily absorb effluent from septic tank absorption fields, but they do not adequately filter the effluent. Absorption fields can be constructed on fill material so that the absorption field can be placed a sufficient distance above the seasonal high water table. Sewage lagoons need to be lined or sealed to prevent seepage. Sewage lagoons need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the water table. Walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Digging in the Els soil during dry periods is easier and reduces water problems. The Ipage soil is generally suited to use as sites for dwellings without basements and small commercial buildings. Dwellings and buildings on the Els soil and dwellings with basements on the Ipage soil need to be constructed on well compacted fill material to overcome wetness caused by the seasonal high water table. Constructing on fill material also provides protection against floods on the Els soil. Damage to roads by frost action can be reduced by providing good surface drainage and by the use of a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. Constructing roads on suitable, well compacted fill material and providing adequate side ditches and culverts help to protect roads from flooding and wetness on the Els soil.

This complex is in capability units VIe-5 dryland and IVe-12 irrigated. The Els soil is in the Subirrigated range site and windbreak suitability group 2S. The Ipage soil is in the Sandy Lowland range site and windbreak suitability group 7.

Em—Elsmere loamy fine sand, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on bottom lands. It is rarely flooded. Individual areas range from 5 to several thousand acres.

The surface layer is dark grayish brown, very friable loamy fine sand about 4 inches thick. The subsurface layer is about 14 inches thick. It is dark gray, very friable loamy fine sand in the upper part and dark grayish brown, very friable fine sand in the lower part. The transitional layer is brown, loose fine sand about 6 inches thick. The underlying material to a depth of more than 60 inches is fine sand. It is very pale brown in the upper part, gray in the middle part, and light gray in the lower part. The underlying material has grayish brown and yellowish brown mottles. In a few places, the surface layer is 6 to 19 inches thick. In places, the surface layer is fine sandy loam. In places, thin loamy layers are between depths of 20 to 40 inches. In a few places, coarse sand or gravelly coarse sand is below a depth of 20 inches.

Included with this soil in mapping are small areas of Ipage and Loup soils. Ipage soils are higher on the landscape and are better drained. The Loup soils are lower on the landscape and are poorly drained and very poorly drained. Also included are small spots that are strongly affected with alkali. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Elsmere soil is rapid, and the available water capacity is low. The organic matter content is moderate, and natural fertility is low. The soil is slightly acid to moderately alkaline. The water intake rate is very high. Runoff is very slow. The seasonal high water table ranges from a depth of 1.5 feet in wet years to about 2.5 feet in dry years.

Most of the acreage of this soil is in native grass and is used as rangeland or hayland. The remaining acreage is used as cropland.

Under dryland farming, this soil is poorly suited to corn, soybeans, and small grains. This soil is susceptible to soil blowing if it is cultivated. It is commonly too wet for cultivation during the wettest seasons. The water table provides subirrigation during dry parts of the year. This soil is difficult to work early in the spring because of wetness caused by the high water table. Alfalfa and other close-growing crops eliminate the need for working this soil in spring and protect it against blowing when the surface is dry. The high water table can drown out the alfalfa in places. Keeping crop residue on the surface helps to control soil blowing.

Under irrigation, this soil is poorly suited to corn, soybeans, alfalfa, and introduced grasses. Sprinkler irrigation is the only suitable method. The soil is too sandy for gravity irrigation. Irrigation water needs to be applied frequently and lightly to prevent waterlogging and deep leaching of plant nutrients. Normally, tiling is not needed, but wetness can be a problem during wet periods of the year. Soil blowing can be controlled by using a stubble mulch system of tillage, returning crop residue to the soil, planting winter cover crops, and using close-growing crops. Barnyard manure can be used to increase the organic matter content and improve fertility.

This soil is suited to range or hayland. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. When the soil is wet, overgrazing can cause compaction and small mounds, making it difficult to graze or harvest for hay. Proper grazing use, timely deferment from grazing or haying, and restricted use during very wet periods help to maintain the native plants in good condition.

Where this soil is used for hayland, mowing needs to be regulated so that the grasses remain vigorous and keep their place in the meadow. In order to allow for carbohydrate storage in the grass plants, mowing should be avoided between boot stage and seed maturity, especially on meadows that are cut each year. The meadow should be mowed before the dominant species reach the boot stage. Nitrogen and phosphate fertilizers can increase hay production. After frost and during winter, animals can usually graze the meadows without damage if the areas are properly stocked.

This soil is suited to trees and shrubs that tolerate occasional wetness. In some years, wetness makes it difficult to establish seedlings and to cultivate between rows. Planting needs to be delayed until the soil begins to dry. The abundant and persistent herbaceous vegetation competes for moisture. Weeds and undesirable grasses can be controlled by cultivation with conventional equipment or by appropriate herbicides.

Septic tank absorption fields can be constructed on fill material so that the absorption fields are placed a sufficient distance above the seasonal high water table. This soil readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent. The poor filtering capacity of this soil can result in pollution of the underground water table. Sewage lagoons need to be lined or sealed to prevent seepage. They need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal high water table. Walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Digging during dry periods helps to reduce wetness and caving problems. Dwellings and buildings need to be constructed on raised, well compacted fill material to overcome wetness caused by the high water table and as protection from flooding. Constructing roads on suitable, well compacted fill material and providing adequate side ditches and culverts help to protect roads from flood damage and wetness. Damage by frost action can be reduced by providing good surface drainage and by the use of a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This Elsmere soil is in capability units IVw-5 dryland and IVw-11 irrigated. It is in the Subirrigated range site and windbreak suitability group 2S.

En—Elsmere loamy fine sand, clayey substratum, 0 to 2 percent slopes. This soil is deep, nearly level, and somewhat poorly drained. It occurs on stream terraces where windblown or alluvial sands are deposited about 3 to 6 feet thick over clayey shale. Individual areas range from 5 to 500 acres.

Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 12 inches thick. The transitional layer is grayish brown, very friable loamy fine sand about 8 inches thick. The underlying material is very pale brown, mottled fine sand to a depth of 56 inches. Light yellowish brown and gray silty clay extends to a depth of more than 60 inches. In places, the surface layer is fine sandy loam. In places, silty clay loam of Tertiary-age material is below a depth of 40 inches, and, in places, it is highly calcareous. In a few places, the clayey material is at a depth of less than 40 inches, but it commonly is below a depth of 60 inches.

Included with this soil in mapping are small areas of Dunday, Ipage, and Wewela soils. Dunday and Ipage soils are in higher positions on the landscape and are better drained. Wewela soils are in similar positions on the landscape, are better drained, and have clayey material closer to the surface. Included soils make up 10 to 15 percent of this map unit.

Permeability of this Elsmere soil is rapid in the upper part and slow in the underlying clayey material. This soil has low available water capacity. The organic matter content is moderate, and natural fertility is low. The soil is slightly acid through mildly alkaline. Runoff is slow. In spring and during wet periods, a water table is perched above the clayey material. In summer, the water table

dries up over much of the area. The seasonal high water table ranges from a depth of about 1.5 feet in wet years to about 2.5 feet in dry years.

This soil is mostly in native grass and is used for rangeland or hay. A few small areas are used as cropland.

Under dryland farming, this soil is poorly suited to corn, alfalfa, sorghum, small grains, and introduced grasses. This soil is susceptible to soil blowing. This soil can be difficult to work early in spring because the water table keeps the surface wet. Alfalfa and other close-growing crops eliminate the need to work the soil in the spring when it is wet and protect it against soil blowing when the surface is dry. During wet parts of the year, the water table provides subirrigation. Tillage practices that keep crop residue on the surface help to control soil blowing.

Under irrigation, this soil is poorly suited to corn, alfalfa, and tame grasses. Soil blowing and wetness are the main problems. Sprinkler irrigation is suitable for this soil. The soil is too sandy for gravity irrigation. Irrigation water needs to be applied frequently and lightly to prevent waterlogging and deep leaching of plant nutrients. Soil blowing can be controlled by using a stubble mulch system of tillage, returning crop residue to the soil, planting winter cover crops, and using close-growing crops. Wetness can be a problem, but normally tiling is not required. Adding barnyard manure increases the organic matter content and natural fertility.

This soil is suited to rangeland, either grazing or haying. Overgrazing, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. In addition, when the soil is wet, overgrazing can cause surface compaction and small mounds, making it difficult to graze or harvest for hay. Proper grazing use, timely deferment from grazing or haying, and restricted use during very wet periods help to maintain the native plants in good condition.

Where this soil is used for hayland, mowing should be regulated so that the grasses remain vigorous and keep their place in the meadow. In order to allow for carbohydrate storage in the grass plants, mowing should be avoided between boot stage and seed maturity, especially on meadows that are cut about the same time each year. The meadow should be mowed before the dominant species reach the boot stage. Nitrogen and phosphate fertilizers usually increase hay production. After frost and during winter, animals can usually graze meadows without damage if the areas are properly stocked.

This soil is suited to trees and shrubs planted in windbreaks. Species selected should be able to tolerate occasional wetness. In some years, wetness makes it difficult to establish seedlings and to cultivate between rows. Planting needs to be delayed until soil is dry. The abundant and persistent herbaceous vegetation competes for moisture and needs to be controlled by cultivation or appropriate herbicides.

This soil readily absorbs effluent from septic tank absorption fields, but it does not adequately filter it. This poor filtering capacity may result in pollution of the underground water table. Septic tank absorption fields can be constructed on fill material so that the absorption fields are placed a sufficient distance above the seasonal high water table. Sewage lagoons need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal high water table. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Digging during dry periods is easier and helps to avoid cave-ins and water problems. Dwellings and buildings need to be constructed on raised, well compacted fill material to overcome wetness caused by the high water table. Constructing roads on suitable, well compacted fill material and providing adequate side ditches and culverts help to protect roads from wetness. Damage to roads by frost action can be reduced by providing good surface drainage and by the use of a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This Elsmere soil is in capability units IVw-5 dryland and IVw-11 irrigated. It is in the Subirrigated range site and windbreak suitability group 2S.

Ep—Elsmere fine sandy loam, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on bottom lands. Flooding is rare. Individual areas range from 5 to more than 1,000 acres.

Typically, the surface layer is dark gray, calcareous, very friable fine sandy loam about 6 inches thick. The subsurface layer is about 10 inches thick. The upper part is dark gray, very friable fine sandy loam, and the lower part is dark gray, very friable loamy fine sand. The transitional layer is grayish brown, very friable loamy sand about 6 inches thick. The underlying material is light brownish gray fine sand to a depth of more than 60 inches. It has yellowish brown mottles. In places, the surface layer is loamy fine sand or loam. In places, coarse sand or gravelly coarse sand is at a depth of 20 to 40 inches.

Included with this soil in mapping are small areas of Gannett, Ipage, Loup, and Ord soils. Gannett and Loup soils are lower on the landscape and are poorly drained and very poorly drained. Ipage soils are higher on the landscape and are moderately well drained. Ord soils are in similar positions on the landscape and have a finer textured transitional layer. Also included are small spots of alkali soils. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Elsmere soil is rapid, and the available water capacity is low. The organic matter content is moderate, and natural fertility is low. The soil ranges from medium acid through moderately alkaline. The water intake rate is very high. Runoff is very slow. The seasonal high water table ranges from a depth of 1.5 feet in wet years to about 2.5 feet in dry years.

Most of the acreage of this soil is in native grass and is used as hayland or rangeland. The rest is used as cropland.

Where dryland farmed, this soil is suitable for corn, alfalfa, soybeans, small grains, and introduced grasses. The high water table causes tillage delays in spring, but it is beneficial to crops in dry years. By using crops, such as alfalfa and grass, that do not require spring cultivation, much of the wetness limitation can be overcome. However, the high water table drowns out alfalfa in some areas. This soil is susceptible to soil blowing in drier periods. Soil blowing can be controlled by keeping crop residue on the soil surface, especially during tillage and seedbed preparation. Cover crops or crop residue is needed to protect the soil in winter.

Under irrigation, this soil is suited to corn, alfalfa, soybeans, and introduced grasses. Sprinkler irrigation is the most suitable method on this soil. Applications of water should be small and frequent to prevent waterlogging and leaching of nutrients. Surface drainage is needed in some fields. Tiling is normally not required for irrigation, but wetness is a limitation early in the year. Adding barnyard manure improves fertility and helps to maintain the organic matter content. Crop residue should be kept on the surface to help control soil blowing.

This soil is suited to rangeland, either grazing or haying. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of native plants. When the soil is wet, overgrazing can cause surface compaction and small mounds, making it difficult to graze or cut for hay. Proper grazing use and restricted use during wet periods help to maintain the native plants in good condition.

Mowing needs to be regulated when this soil is used for hayland so that grasses remain vigorous and keep their place in the meadow. Mowing should be avoided between boot stage and seed maturity, especially on meadows cut about the same time each year. The meadow should be mowed before the dominant grasses reach the boot stage. After frost and during winter, livestock can graze the meadows without damage if the area is properly stocked.

This soil is suited to trees and shrubs that tolerate occasional wetness. In some years, wetness makes it difficult to establish seedlings and to cultivate between rows. The soil should be tilled and seedlings planted after the soil has begun to dry. The abundant and persistent herbaceous vegetation competes for moisture. Weeds and grasses can be controlled by cultivation and timely use of herbicides.

Septic tank absorption fields can be constructed on fill material so that the absorption field is placed a sufficient distance above the seasonal high water table. This soil readily absorbs effluent from septic tank absorption fields, but it does not adequately filter the effluent. This poor filtering capacity can result in pollution of the underground water table. Sewage lagoons need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal water table. They need to be lined or sealed to prevent seepage. Walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Digging during dry periods helps to reduce water and caving problems. Dwellings and buildings need to be constructed on raised, well compacted fill material to overcome wetness caused by the high water table and as protection from flooding. Constructing roads on suitable, well compacted fill material and providing adequate side ditches and culverts help to protect roads from flood damage and wetness. Damage by frost action can be reduced by providing good surface drainage and by the use of a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This Elsmere soil is in capability units IIIw-6 dryland and IIIw-11 irrigated. It is in the Subirrigated range site and windbreak suitability group 2S.

EsB—Elsmere-Ipage loamy fine sands, 0 to 3 percent slopes. This complex consists of deep, nearly level Elsmere soil and deep, nearly level to very gently sloping Ipage soil on bottom lands. The somewhat poorly drained Elsmere soil is in the swales and is rarely flooded. The moderately well drained Ipage soil is on slightly higher bottom land positions and is not flooded. Individual areas of this complex range from 10 to several thousand acres. The complex is 25 to 65 percent Elsmere soil and 20 to 60 percent Ipage soil. The two soils are so intricately mixed that it was not practical to separate them in mapping.

Typically, the Elsmere soil has a surface layer of dark gray, very friable loamy fine sand about 12 inches thick. Below this is a transitional layer of grayish brown, loose fine sand about 11 inches thick. The underlying material is light gray fine sand to a depth of more than 60 inches. It has yellowish brown mottles. In places, the surface layer is fine sandy loam. In some areas, the surface layer is 6 to 9 inches thick. In a few places, coarse sand or gravelly coarse sand is between depths of 20 and 40 inches. In places, loamy material is below a depth of 40 inches.

Typically, the Ipage soil has a surface layer of gray, very friable loamy fine sand about 7 inches thick. The transitional layer is grayish brown, loose fine sand about

11 inches thick. The underlying material is light gray fine sand to a depth of more than 60 inches. It has yellowish brown mottles below a depth of 30 inches. In places, the surface layer is loamy sand or fine sand. In places, the surface layer is 10 to 18 inches thick. In a few places, dark buried layers are below a depth of 40 inches. In a few places, coarse sand or gravelly coarse sand is between depths of 20 and 40 inches.

Included with these soils in mapping are small areas of Dunday, Loup, and Valentine soils. Loup soils are poorly drained and very poorly drained, are on the lower parts of the landscape, and have a higher water table than Elsmere soils. Dunday and Valentine soils are higher on the landscape than Ipage soils and are somewhat excessively drained. Included soils make up 10 to 15 percent of the complex.

Permeability is rapid in both the Elsmere and Ipage soils. Both soils have low available water capacity. The organic matter content is moderate in the Elsmere soil and low in the Ipage soil. Natural fertility is low in both soils. The Elsmere soil is medium acid to mildly alkaline, and the Ipage soil is medium acid to neutral. The water intake rate is very high in both soils. Runoff is slow to very slow. The seasonal high water table in the Elsmere soil ranges from a depth of about 1.5 feet in wet years to about 2.5 feet in dry years. The seasonal high water table in the Ipage soil ranges from a depth of about 3 feet in wet years to about 6 feet in dry years.

Most of the acreage of these soils is in native grass and is used as rangeland or hayland. A few areas are used as cropland.

Under dryland farming, this complex is poorly suited to corn, alfalfa, soybeans, and small grains. If not protected, areas of these soils are highly susceptible to soil blowing. Wetness, caused by the high water table, can be a problem in the Elsmere soil. Soil blowing can be reduced, moisture conserved, and the organic matter content and fertility maintained by using a cropping system that keeps the soil covered with crops, grass, or crop residue. Returning crop residue to the soil and using barnyard manure help to increase the organic matter content and improve fertility.

Under irrigation, this complex is suited to corn, soybeans, alfalfa, and introduced grasses. Sprinkler irrigation is the only suitable method of applying irrigation water. The soils are too sandy for gravity irrigation. Applications of water need to be light and frequent to prevent leaching of nutrients. Soil blowing is a hazard and can be controlled by using winter cover crops, using close-growing crops, and leaving crop residue on the surface. The high water table in the Elsmere soil can cause wetness problems. Normally, tiling is not required for these soils to be irrigated successfully.

This complex is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the vegetative cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and restricted use during wet periods help to maintain the native plants in good condition.

Where this complex is used as hayland, mowing needs to be regulated so that the grasses remain vigorous. Mowing should be avoided between boot stage and seed maturity. The meadow should be cut before the dominant grasses reach the boot stage. Fertilization can increase hay production. After frost and during winter, livestock can graze the meadows without damage if the areas are properly stocked.

This complex is suited to planting trees in windbreaks if soil blowing is controlled by maintaining strips of sod or other vegetation between the rows. On the Elsmere soil, the trees and shrubs must be able to tolerate occasional wetness. Establishing trees can be a problem in wet seasons. On the Ipage soil, soil blowing, drought, and competition for moisture from grass and weeds are the main problems. Soil blowing can be controlled by maintaining strips of sod or a cover crop between the tree rows. Irrigation can be needed to provide supplemental moisture during periods of low rainfall. Weeds and grasses can be controlled by cultivation and use of appropriate herbicides.

These soils readily absorb the effluent from septic tank absorption fields, but they do not adequately filter the effluent. Where these soils are used for septic tank absorption fields, the poor filtering capacity can result in pollution of the underground water table. Septic tank absorption fields can be constructed on fill material so that the absorption field is placed a sufficient distance above the seasonal high water table. Sewage lagoons need to be lined or sealed to prevent seepage. They also need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the water table. Walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Digging in the Elsmere soil is easier during dry periods and helps to reduce water problems. The Ipage soil is generally suited to use for dwellings without basements and small commercial buildings. Dwellings and buildings on the Elsmere soil and dwellings with basements on the Ipage soil need to be constructed on well compacted fill material to overcome wetness caused by the high water table and as protection against flooding on the Elsmere soil. Damage to roads by frost action can be reduced by providing good surface drainage and by the use of a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. Constructing roads on suitable, well compacted fill material and providing adequate side ditches and culverts help to protect roads from flood damage and wetness on the Elsmere soil.

This complex is in capability units IVe-5 dryland and IVe-11 irrigated. The Elsmere soil is in the Subirrigated

range site and windbreak suitability group 2S. The Ipage soil is in the Sandy Lowland range site and windbreak suitability group 5.

Eu—Elsmere-Selia loamy fine sands, 0 to 2 percent slopes. These deep, nearly level, somewhat poorly drained soils are on bottom lands. Individual areas range from 10 to 300 acres. This complex is 45 to 60 percent Elsmere soil and 25 to 40 percent Selia soil. Both soils are on similar topographic positions. They are rarely flooded. Areas of Selia soil are irregular in shape and range from about 5 to 100 feet across. They are surrounded by the larger areas of Elsmere soil. The two soils are so intricately mixed that it was not practical to separate them in mapping.

Typically, the Elsmere soil has a surface layer of dark gray, very friable, calcareous loamy fine sand about 11 inches thick. The transitional layer is gray, very friable, calcareous loamy sand about 6 inches thick. The underlying material is light brownish gray fine sand to a depth of more than 60 inches. It has yellowish brown mottles. Dark buried layers are common. In places, the surface layer is less than 10 inches thick. A few areas have loamy material, coarse sand, or gravelly coarse sand at a depth of 20 to 60 inches.

Typically, the Selia soil has a surface layer of gray, very friable loamy fine sand about 3 inches thick. The subsurface layer is light gray, loose fine sand about 1 inch thick. The subsoil is calcareous loamy fine sand about 21 inches thick. The upper part of the subsoil is dark gray, the middle part is grayish brown, and the lower part is light brownish gray. The subsoil is very friable when moist, but it becomes very hard when dry. The underlying material to a depth of more than 60 inches is light gray fine sand in the upper part and grayish brown sand in the lower part. It has reddish brown mottles. In places, the surface layer is fine sandy loam. In places, loamy material is at a depth of 40 to 60 inches.

Included with these soils in mapping are small areas of Loup and Ord soils. Loup soils are slightly lower on the landscape and are poorly drained or very poorly drained. Ord soils have a finer textured transitional layer than the Elsmere soil. Ord soils are in similar postions on the landscape as the major soils. Included soils make up 15 to 25 percent of the complex.

Permeability is rapid in the Elsmere soil. In the Selia soil, permeability is slow in the subsoil and rapid in the underlying material. The available water capacity and natural fertility are low in both soils. The organic matter content is moderate in both soils. The water intake rate is very high in the Elsmere soil and moderately low in the Selia soil. Runoff is slow or very slow. Some areas of the Selia soil in microdepressions are ponded. The Elsmere soil is medium acid to moderately alkaline. The Selia soil is neutral to very strongly alkaline. The Selia soil contains high amounts of sodium. In both soils, the seasonal high water table ranges from a depth of about 1.5 feet in wet years to about 2.5 feet in dry years. The Elsmere soil is easy to till. Areas of the Selia soil are difficult to till because the soil has poor structure and becomes very hard when dry.

Nearly all of the acreage of this complex is in native grass and is used for grazing or hayland. A small acreage is used for cropland.

Under dryland farming, these soils are unsuited to cultivation because of the high alkalinity in the Selia soil. The alkali content makes it difficult for crops to take up water; consequently, the Selia soil is quite droughty. The Elsmere soil in this complex is suited to dryfarmed crops, but it is so intermixed with the Selia soil that it cannot be tilled separately.

Under irrigation, these soils are poorly suited to corn, alfalfa, and alkali-tolerant grasses. Crops do not grow well on the Selia soil. The principal concerns of management are alkalinity, maintenance of fertility, and the hazard of soil blowing. Sprinkler irrigation is better suited to these soils than other methods of irrigation. The soils are too sandy for gravity irrigation. Irrigation water needs to be applied frequently and lightly to prevent waterlogging and deep leaching of the plant nutrients. In places, grading is needed to fill in small depressional areas and to improve surface drainage. Normally, tiling is not required to irrigate these soils, but the water table is a concern in periods of above normal rainfall. During dry periods, the water table provides subirrigation. Soil blowing is a hazard during dry periods if the soil surface is unprotected. Soil blowing can be controlled by using close-growing crops, stubble mulch tillage, and winter cover crops. Fertility needs to be balanced, because the alkalinity in the Selia soil makes many of the nutrients unavailable to plants. Adding barnyard manure and other organic matter in large quantities to areas of the Selia soil helps to make the soil more friable and increases water intake. Soil fertility can also be improved by growing legumes and returning crop residue to the soil. Chemicals are needed to neutralize the alkali in the Selia soil.

Technical help is needed before reclamation is started. The area needs to be fully investigated. Reclamation of alkali soils is difficult, expensive, and time consuming.

Alkali conditions can be improved by adding chemical amendments, leaching the soil, and using practices that build soil structure (*12, 13*). Chemical amendments, such as gypsum and sulfur, are expensive; it is sound practice to determine the kind and amount of amendment needed on the basis of chemical soil tests (*3*). Leaching is not successful if the water table is close to the surface. The water table should be at least 4.5 to 5 feet below the surface during most of the growing season. Where suitable outlets are available, tile drains or open ditches can be used to lower the water table. The amount of leaching water that enters the soil determines how much salt is removed from the soil. The common method of

leaching is to pond water over the alkali area. Leaching by sprinkler irrigation is generally more costly than other methods. There is a tendency to apply too little water by this method, and, as a result, complete leaching of salt beyond the root zone does not occur. After soil amendments have been added and leaching is completed, applications of manure or other forms of organic matter help to improve the soil structure.

The soils of this complex are suited to native grass used for grazing or hayland. However, the alkali problem is not easily controlled. Most ranchers make allowances as needed in grazing usage and mowing patterns to fit the alkali soil conditions. The Selia soil produces mostly short grasses, such as saltgrass and other alkali-tolerant grasses. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. In addition, when the soils are wet, overgrazing can cause small mounds, making it difficult to graze or mow for hay. Proper grazing use, timely deferment from grazing or haying, and restricted use during wet periods help to maintain the plant community in good condition.

Where these soils are used for hayland, mowing needs to be regulated so that the grasses remain vigorous and keep their place in the meadow. To allow for carbohydrate storage in the grass, mowing should be avoided between boot stage and seed maturity. The meadow should be cut before the dominant species reach the boot stage. After frost and during the winter, range animals can graze the meadows without damage if the areas are properly stocked.

The Elsmere soil in this complex is suited to trees and shrubs planted in windbreaks. The Selia soil is unsuited. Because of the intermixed composition of the soils, they must be treated as one unit. The capacity for survival and growth of adapted species is good in the Elsmere soil if the species selected can tolerate occasional wetness from the water table. In the Selia soil, the capacity for survival and growth of adapted species is poor. Only trees and shrubs that can tolerate occasional wetness and alkali conditions are suited. In wet years, planting needs to be delayed until the soil is sufficiently dry. The effect of alkali can be minimized by using salt tolerant species. The abundant and persistent herbaceous vegetation, which grows on these soils, is a concern because it competes with the trees. Weeds and grasses between the rows can be controlled by cultivating with conventional equipment or by timely use of the appropriate herbicides. Areas in the rows and close to the trees can be hoed by hand.

Septic tank absorption fields can be constructed on fill material so that the absorption field is placed a sufficient distance above the seasonal high water table. These soils readily absorb effluent from the septic tank absorption fields, but they do not adequately filter the effluent. The poor filtering capacity can cause pollution of the underground water table. Sewage lagoons need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal high water table. They need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Digging in these soils during dry periods reduces water and caving problems. Dwellings and buildings can be constructed on well compacted fill material to overcome wetness caused by the high water and as protection against flooding. Constructing roads on suitable, well compacted fill material and providing adequate side ditches and culverts help to protect roads from flood damage and wetness. Damage by frost action can be reduced by providing good surface drainage and by using a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

The soils in this complex are in capability units VIs-1 dryland and IVs-11 irrigated. The Elsmere soil is in the Subirrigated range site and windbreak suitability group 2S. The Selia soil is in the Saline Subirrigated range site and windbreak suitability group 10.

Fm—Fillmore silt loam, 0 to 2 percent slopes. This soil is deep, nearly level, and poorly drained. It occurs in depressions in the uplands and is occasionally ponded by runoff from adjacent soils for short periods following local heavy rains. Individual areas are oblong to round and range from 5 to 40 acres.

Typically, the surface layer is very friable silt loam about 12 inches thick. It is dark grayish brown in the upper part and dark gray in the lower part. The subsurface layer is gray, very friable silt loam about 4 inches thick. The subsoil is about 34 inches thick. The upper part is very firm, dark gray silty clay, and the lower part is dark grayish brown, firm silty clay loam. The underlying material is light brownish gray sandy clay loam to a depth of more than 60 inches. In places, the surface layer is silty clay loam, loam, or fine sandy loam. In a few places, sand or gravelly coarse sand is below a depth of 40 inches.

Included with this soil in mapping are small areas of Bazile, Jansen, and Trent soils. Bazile and Jansen soils are underlain by sand or gravelly coarse sand at a depth of 20 to 40 inches. Trent soils have less clay in the subsoil. These soils are higher on the landscape and are better drained than Fillmore soils. Included soils make up 5 to 10 percent of this map unit.

Permeability in this Fillmore soil is very slow, and the available water capacity is high. The organic matter content is moderate, and natural fertility is medium. The soil ranges from medium acid through moderately alkaline. During some seasons, crops are damaged by excess water. This soil is droughty during dry weather; it releases moisture slowly to plants. Runoff is very slow or ponded. The very slow permeability of the subsoil allows

only a small amount of the ponded water to move through the soil. Most of the surface water evaporates.

Some of the acreage of this soil is cultivated. The rest is in native grass and is used as rangeland.

Under dryland farming, this soil is suited to corn, sorghum, small grains, or introduced grasses. The main problem is the ponding of runoff water on the surface. Planting is delayed, and harvest is difficult in wet years if drainage is not provided. Proper drainage can be supplied by installing surface drainageways or tile drains with proper outlets. Returning crop residue and barnyard manure to the soil helps to maintain and improve the organic matter content, fertility, and soil tilth. It also increases the water intake rate.

Under irrigation, this soil is suited to corn, alfalfa, sorghum, and introduced grasses if the area is properly drained. Ponding of water is the main hazard and can delay planting and make harvesting difficult. Surface drainageways or tile drains with proper outlets are needed to provide drainage. Practices that return crop residue to the soil help to maintain or increase the organic matter content, fertility, and water intake rate. Adding barnyard manure increases the organic matter content and fertility.

This soil is suited to use as rangeland. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment, and a planned grazing system help to maintain or improve the range condition. If livestock is allowed on the area when it is wet, the native plants can be damaged.

This soil is suited to trees and shrubs planted in windbreaks if drainage is provided so that water does not pond around the trees and shrubs. The establishment of seedlings can be a problem during wet years unless the soil is adequately drained. Trees can be planted on raised or fill areas to help prevent loss from ponding. Good site preparation and timely cultivation or use of herbicides help to control competing vegetation. Farming soils in adjacent areas on the contour and using minimum tillage practices help to decrease runoff onto the Fillmore soil.

This soil is not suited to use as septic tank absorption fields, dwellings, or small commercial buildings because of ponding. A suitable alternate site is needed. Sewage lagoons need to be diked as protection from ponding. Digging needs to be done during dry periods, or excavations need to be diked for protection from ponding. Constructing roads on suitable, well compacted fill material above the ponding level and providing adequate side ditches and culverts help to protect roads from damage by ponding water. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to ensure better performance. Damage to roads and streets by frost action can be reduced by providing good surface drainage. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This Fillmore soil is in capability units IIIw-2 dryland and IIIw-2 irrigated. It is in the Clayey Overflow range site and windbreak suitability group 2W.

Gb—Gannett loam, 0 to 2 percent slopes. This deep, nearly level, poorly drained soil is on bottoms of wet valleys and is rarely flooded. Individual areas range from 5 to 500 acres.

Typically, the surface layer is dark gray, very friable, calcareous loam about 8 inches thick. The subsurface layer is dark gray, very friable loam about 13 inches thick. It is stratified with thin layers of fine sandy loam and sandy clay loam. The underlying material is light gray fine sand stratified with thin layers of loamy fine sand and silt loam. The underlying material extends to a depth of more than 60 inches. It has yellowish brown mottles. In a few places, the surface layer is sandy clay loam or fine sandy loam. In places, the combined thickness of the surface and subsurface layers is less than 16 inches. In places, strata of silty clay loam are in the surface layer. In low areas and in drainageways, the water table can be above the surface for a few days in the spring or during wet periods.

Included with this soil in mapping are small areas of Elsmere, Marlake, and Ord soils. Elsmere and Ord soils are in higher positions on the landscape and are somewhat poorly drained. Marlake soils are in the lowest positions on the landscape and have a higher seasonal water table. A few spots are affected by alkali. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Gannet soil is moderately rapid in the solum and rapid in the underlying material. The available water capacity is moderate. Natural fertility is medium, and the organic matter content is high. The soil is mildly alkaline or moderately alkaline. Runoff is very slow. The seasonal high water table ranges from the surface in wet years to a depth of about 1.5 feet in dry years. It normally recedes to a depth of about 2 to 3 feet by late in summer.

Most of the acreage of this soil is in native grass and is used as hayland or rangeland.

This soil is unsuited to cropland because of the high water table.

This soil is suited to rangeland, either grazing or haying. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. In addition, when the soil is wet, overgrazing can cause surface compaction and small mounds, making it difficult to graze or harvest for hay. Proper grazing use, timely deferment from grazing, and restricted use during very wet periods help to maintain the native plants in good condition.

Where this soil is used for hayland, mowing needs to be regulated so that the grasses remain vigorous. In order to allow for carbohydrate storage in the grass plants, mowing should be avoided between boot stage and seed maturity. Large meadows can be divided into three parts and mowed in rotation. One-third should be mowed two weeks before the plants enter the boot stage, one-third at boot stage, and one-third early in the flowering period. The areas should be rotated in successive years. If a rancher has plenty of hay, the entire area can be left idle one year in three, particularly if the rotation mowing plan is not followed. Hay production can be increased by proper fertilization with nitrogen and phosphorus. After frost and during winter, range animals can graze the meadows without damage if the areas are properly stocked. Livestock must be removed before frost leaves the soil and the water table reaches a high level.

This soil is poorly suited to planting trees and shrubs in windbreaks. Only trees and shrubs tolerant of a very high water table are suited to this soil. Establishment of seedlings can be a problem in wet years and can require special methods of planting so that seedlings do not drown. Planting should be delayed until the soil dries out. Weeds and undesirable grasses between the rows can be controlled by cultivation and timely use of herbicides. Areas close to the trees can be rototilled or hoed by hand.

This soil is generally not suited to septic tank absorption fields and dwellings because of wetness. A suitable alternate site is needed. Sewage lagoons need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal high water table. Sewage lagoons need to be lined or sealed to prevent seepage. Constructing roads on suitable, well compacted fill material and providing adequate side ditches and culverts help to protect roads from wetness. Damage to roads by frost action can be reduced by providing good surface drainage and by the use of a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This Gannett soil is in capability unit Vw-7 dryland. It is in the Wet Subirrigated range site and windbreak suitability group 2D.

Gf—Gannett loam, wet, 0 to 2 percent slopes. This deep, nearly level, very poorly drained soil is on bottoms of wet valleys and in depressions. This soil is rarely flooded, but it is occasionally ponded by water from a very high water table. Individual areas range from 5 to 250 acres.

Typically, the surface layer is very dark gray, very friable loam about 12 inches thick. The subsurface layer is dark gray and gray, friable fine sandy loam about 10 inches thick. It is stratified with thin layers of loamy fine sand and loam. The underlying material is light gray loamy sand and fine sand with brown mottles to a depth of more than 60 inches. The surface layer in places is sandy clay loam or clay loam. In places, the combined thickness of the surface layer and subsurface layer is less than 16 inches.

Included with this soil in mapping are small areas of Elsmere, Marlake, and Ord soils. Elsmere and Ord soils are in higher positions on the landscape and are somewhat poorly drained. The Marlake soils are lower on the landscape, and the water table is above the surface for longer periods. Alkali spots are common near the outer edges of this map unit. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Gannett soil is moderately rapid in the solum and rapid in the underlying material. The available water capacity is moderate. Natural fertility is medium, and the organic matter content is high. The soil is mildly alkaline or moderately alkaline. Runoff is very slow to ponded. The seasonal high water table ranges from about 0.5 foot above the surface in wet years to about 1 foot below the surface in dry years. This soil can have water above the surface for a week or more at a time during wet periods. The water table normally recedes to a depth of about 1 foot to 2 feet below the surface by late in summer.

All the acreage of this soil is in native grass and is used as rangeland or hayland. The soil is unsuited to cropland because of wetness.

This soil is suited to native hay rangeland. Improper haying time and improper mowing heights reduce the protective cover and cause deterioration of the native plants. Extreme wetness makes haying operations practically impossible during wet periods. The high water table has drowned out most of the bluestem, switchgrass, and indiangrass. Some meadows can be improved by installing V-ditches to hasten surface drainage and by seeding reed canarygrass into the meadow. Mowing needs to be regulated so that grasses remain vigorous and healthy. A proper mowing sequence should be followed. The meadow should be cut before the dominant species reach the boot stage. Mowing should be avoided between boot stage and seed maturity to allow for carbohydrate storage in the grass plants. After frost and during winter months, range animals can graze without damage if the meadows are properly stocked. Range animals must be removed before frost leaves the soil and the water table reaches a high level.

This soil is unsuited to trees and shrubs planted in windbreaks because of the very high water table.

This soil is not suited to septic tank absorption fields and dwellings because of wetness. A suitable alternate site is needed. Sewage lagoons need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal high water table and the ponding level. Sewage lagoons need to be lined or sealed to prevent seepage and diked as protection from

ponding. Constructing roads on suitable, well compacted fill material above the ponding level and providing adequate side ditches and culverts help to protect roads from damage by ponding and wetness from the seasonal high water table. Damage to roads by frost action can be reduced by providing good surface drainage and by use of a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This Gannett soil is in capability unit Vw-7 dryland. It is in the Wetland range site and windbreak suitability group 10.

Ia—Inavale sand, channeled. This deep, somewhat excessively drained soil is on narrow flood plains along drainageways. Slopes range from 0 to 2 percent. This soil is subject to frequent flooding. Areas of this soil are long and narrow and are dissected by old dry creekbeds and channels that meander through the flood plains. Individual areas of this soil range from 5 to 200 acres.

Typically, the surface layer is gray, loose sand about 10 inches thick. It is stratified with loamy sand. The underlying material extends to a depth of more than 60 inches. It is light gray sand stratified with coarse sands in the upper part and mottled, coarse sand stratified with gravelly coarse sand in the lower part. The underlying material is 2 to 15 percent gravel by volume. In places, the surface layer is loamy sand or sandy loam. In places, the underlying material is gravelly coarse sand.

Included with this soil in mapping are small areas of Boel, Meadin, Pivot, and Simeon soils. Boel soils are lower on the landscape and somewhat poorly drained. Meadin, Pivot, and Simeon soils are higher on the landscape. Meadin soils have gravelly coarse sand at a depth of 8 to 20 inches. Pivot soils have a darker and thicker surface layer. Simeon soils do not have stratification and are excessively drained. Also included are some steep slopes and escarpments along the sides of the drainageways. Riverwash is included along some drainageways. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Inavale soil is rapid, and the available water capacity is low. The organic matter content and natural fertility are low. The soil is slightly acid or neutral. Runoff is slow. Any seasonal high water table that is present is below a depth of 6 feet.

All of the acreage of this soil is used as rangeland.

This soil is not suited to cultivation because of the hazard of flooding. Erosion is a hazard because of the scouring action of floodwaters.

This soil is suited to rangeland. This use is effective in controlling erosion. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. Proper grazing use and timely deferment from grazing help to maintain or improve the range condition. Maintaining a good stand of desirable native grasses is difficult because of the scouring action and deposition of sediment caused by the floodwaters.

This soil is generally not suited to trees planted in windbreaks because of the hazard of flooding. Some small areas can be used for recreational, wildlife, and forestation plantings if tolerant trees and shrubs are hand planted or other approved special practices are used. Wooded or brushy areas that are not used for grazing can provide excellent habitat for wildlife.

This soil is not suited to septic tank absorption fields, sewage lagoons, and building sites because of flooding. A suitable alternate site is needed. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Constructing roads on suitable, well compacted fill material above the flood level and providing adequate side ditches and culverts help to protect roads from flood damage.

This Inavale soil is in capability unit VIw-7. It is in the Sandy Lowland range site and windbreak suitability group 10.

Ib—Inavale fine sand, 0 to 2 percent slopes. This deep, nearly level, somewhat excessively drained soil is on low ridges on bottom lands along major drainageways. Many areas are dissected by drainage channels, and some have low hummocks. This soil is on the highest part of the flood plain and is rarely flooded. Individual areas range from 5 to 160 acres.

Typically, the surface layer is grayish brown, loose fine sand about 9 inches thick. The transitional layer is pale brown, loose fine sand about 5 inches thick. The underlying material is fine sand stratified with loamy sand and sand to a depth of more than 60 inches. It is gray in the upper part and light gray in the lower part. Yellowish brown mottles are below a depth of 44 inches. Dark buried layers are common. In places, coarse sand or gravelly coarse sand is below a depth of 20 inches. In a few places, the surface layer is loamy sand or gravelly sand.

Included with this soil in mapping are small areas of Boel and Simeon soils. Boel soils are lower on the landscape and have a higher seasonal water table. Simeon soils are higher on the landscape and have coarser texture. Included soils make up 10 to 15 percent of the map unit.

Permeability of the Inavale soil is rapid, and the available water capacity is low. Natural fertility and organic matter content are low. The soil is slightly acid or neutral. The water table is generally below a depth of 6 feet during the summer, but it is sometimes higher in the spring when nearby streams are at full flow from runoff and snowmelt. The water intake rate is very high. Surface runoff is slow.

Areas of this soil are mostly in native grass and are managed along with adjacent areas of rangeland or hayland.

This soil is unsuited to cultivated crops under dryland management. It is droughty and highly susceptible to soil blowing if the grass cover is removed.

Under irrigation, this soil is poorly suited to corn, alfalfa, and introduced grasses. Sprinkler irrigation is the only system suited. Water needs to be applied lightly and frequently to prevent leaching of nutrients below the plant root zone. Using winter cover crops and leaving crop residue on the surface help to control soil blowing. Adding barnyard manure to the soil helps to increase the organic matter content and improve fertility. Most areas of this soil are small and are managed along with adjacent areas of other soils.

This soil is suited to native grass that is used as range or hayland. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees planted in windbreaks, but the soil is so loose that trees have to be planted in shallow furrows and cannot be cultivated with conventional equipment. Young seedlings can be damaged by high winds and covered by drifting sand. Soil blowing can be prevented by maintaining strips of sod between the rows. Areas near trees can be hoed by hand to control weeds and undesirable grasses that compete with trees for moisture.

If this soil is used for septic tank absorption fields, care should be taken so that seepage does not contaminate the underground water table. This soil readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent. Sewage lagoons need to be lined or sealed to prevent seepage and diked for protection from flooding. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Dwellings and buildings can be constructed on elevated, well compacted fill material as protection against flooding. Constructing roads on suitable, well compacted fill material above flood level and providing adequate side ditches and culverts help to protect roads from flood damage.

This Inavale soil is in capability units VIe-5 dryland and IVe-12 irrigated. It is in the Sandy Lowland range site and windbreak suitability group 7.

Id—Inavale loamy fine sand, 0 to 2 percent slopes. This deep, nearly level, somewhat excessively drained soil is on bottom lands. It is on low ridges or sand flats on the highest part of the flood plain and is rarely flooded. Some areas are dissected by shallow drainage channels. Individual areas range from 5 to 200 acres.

Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 5 inches thick. The transitional layer is grayish brown, loose fine sand about 16 inches thick. The underlying material to a depth of 60 inches or more is light gray fine sand with thin strata of lighter and darker fine sand and sandy loam. Yellowish brown mottles are below a depth of 42 inches. In places, coarse sand or gravelly coarse sand is below a depth of 20 inches. In a few places, the surface layer is fine sandy loam or sand.

Included with this soil in mapping are small areas of Boel and Pivot soils. Boel soils are in lower parts of the landscape and are somewhat poorly drained. Pivot soils are on higher positions and have gravelly coarse sand between depths of 20 and 40 inches. Also included are some low lying areas that are flooded occasionally for short periods following heavy rains. Included soils make up 10 to 20 percent of this map unit.

Permeability of this Inavale soil is rapid, and the available water capacity is low. Natural fertility and organic matter content are low. The soil is slightly acid or neutral. The water table is normally below a depth of 6 feet during summer, but it can be higher in spring when nearby streams are at full flow from runoff and snowmelt. The water intake rate is very high. Surface runoff is slow.

Most areas of this soil are in native grass and are used for grazing or hayland. A few small areas are used as cropland.

Under dryland farming, this soil is poorly suited to corn, soybeans, small grains, and alfalfa. Small grains and the first cutting of alfalfa are generally better suited crops because they mature in the spring when there is more rainfall. Soil blowing is a hazard. Soil blowing can be reduced, moisture conserved, and the organic matter content and fertility maintained by using a cropping system that keeps the soil covered with crops, grass, or crop residue.

Under sprinkler irrigation, this soil is suited to corn, soybeans, small grains, alfalfa, and introduced grasses. Frequent applications of water are needed because the available water capacity is low, and light applications are needed to avoid excessive leaching of the plant nutrients. Returning crop residue to the soil and using barnyard manure help to increase the organic matter content and improve fertility. Crop residue left on the surface helps to control soil blowing.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use and timely deferment from grazing or haying help to maintain or improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. Soil blowing can be controlled by maintaining strips of sod or a cover crop between the tree rows. Cultivation generally needs to be restricted to the tree rows. Weeds and undesirable grasses compete

with the trees for moisture. Areas near the trees can be rototilled or hoed by hand.

Care should be taken so that seepage does not contaminate the underground water table if this soil is used for septic tank absorption fields. The soil readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent. Sewage lagoons need to be lined and sealed to prevent seepage. They also need to be diked as protection from flooding. Walls or sides of excavations can be temporarily shored to prevent sloughing or caving. Dwellings and buildings can be constructed on elevated, well compacted fill material as protection against flooding. Constructing roads on suitable, well compacted fill material above flood level and providing adequate side ditches and culverts help to protect roads from flood damage.

This Inavale soil is in capability units IVe-5 dryland and IVe-11 irrigated. It is in the Sandy Lowland range site and windbreak suitability group 5.

IfB—Ipage sand, 0 to 3 percent slopes. This soil is deep, nearly level to very gently sloping, and moderately well drained. It is on low hummocks or ridges on stream terraces in broad valleys near areas of sandhills. Individual areas range from 5 to 500 acres.

Typically, the surface layer is grayish brown, loose sand about 6 inches thick. The transitional layer is brown, loose sand about 8 inches thick. The underlying material is very pale brown sand to a depth of more than 60 inches. It has yellowish brown mottles below a depth of about 32 inches. In places, the surface layer is fine sand or loamy sand. In a few places, coarse sand or gravelly coarse sand is between depths of 20 and 40 inches.

Included with this soil in mapping are small areas of Els, Tryon, and Valentine soils. Els and Tryon soils are in lower positions on the landscape. Els soils are somewhat poorly drained, and Tryon soils are poorly drained or very poorly drained. Valentine soils are higher on the landscape, on the steeper ridges and knolls. They are excessively drained. Included soils make up 10 to 15 percent of the map unit.

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

Nearly all areas of this soil are in native grass and are used as range or hayland. A few areas are irrigated cropland.

Under dryland farming, this soil is unsuited to crops because of droughtiness and the hazard of soil blowing.

Under sprinkler irrigation, this soil is poorly suited to corn, alfalfa, and introduced grasses. This soil is too sandy for gravity methods of irrigation. Water should be applied lightly and frequently to prevent leaching of nutrients. Using winter cover crops, using close-growing crops, and leaving crop residue on the soil surface help to control soil blowing. Barnyard manure helps to maintain fertility and increase the organic matter content.

This soil is suited to rangeland, either grazing or haying. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights help to reduce the vegetative cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees, but the soil is so loose that trees have to be planted in shallow furrows and cannot be cultivated. Young seedlings can be damaged by high winds and covered by drifting sand. Strips of sod or cover crops between the rows can reduce soil blowing. Areas near the trees can be rototilled or hoed by hand.

This soil is generally suited to use as sites for dwellings without basements and small commercial buildings. If this soil is used for septic tank absorption fields, care should be taken so that seepage does not contaminate the underground water table. The soil readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent. Absorption fields can be constructed on fill material so that the field is placed a sufficient distance above the seasonal high water table. Sewage lagoons need to be lined or sealed to prevent seepage. Sewage lagoons also need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal high water table. Walls of shallow excavations can be temporarily shored to prevent sloughing or caving. Buildings with basements need to be constructed on raised, well compacted fill material to overcome wetness caused by the high water table. Damage to roads by frost action can be reduced by providing good surface drainage and by use of a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate side ditches help to provide the needed drainage.

This Ipage soil is in capability units VIe-5 dryland and IVe-12 irrigated. It is in the Sandy Lowland range site and windbreak suitability group 7.

IgB—Ipage loamy sand, 0 to 3 percent slopes. This deep, nearly level to very gently sloping, moderately well drained soil is mostly on stream terraces and in sandhill valleys. It also occurs in upland areas where eolian sand is underlain with clayey and loamy material. Individual areas range from 5 to 500 acres.

Typically, the surface layer is dark grayish brown, very friable loamy sand about 7 inches thick. The transitional layer is brown, loose fine sand about 5 inches thick. The underlying material is very pale brown fine sand to a

depth of more than 60 inches. It has yellowish brown mottles below a depth of 32 inches. In places, the surface layer is 10 to 18 inches thick. In a few places, coarse sand or gravelly coarse sand is between depths of 20 and 40 inches. In a few places, clayey or loamy material is below a depth of 40 inches.

Included with this soil in mapping are small areas of Elsmere, Loup, and Valentine soils. Elsmere and Loup soils are on the lower parts of the landscape. Elsmere soils are somewhat poorly drained, and Loup soils are poorly drained and very poorly drained. Valentine soils are higher on the landscape and are excessively drained. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Ipage soil is rapid, and the available water capacity is low. The organic matter content and natural fertility are low. The soil is medium acid to neutral. The water intake rate is very high. Runoff is slow. The seasonal high water table ranges from a depth of about 3 feet in wet years to about 6 feet in dry years.

Most of the acreage of this soil is in rangeland and is used for grazing or hayland. A small acreage is used as cropland.

Under dryland farming, this soil is poorly suited to corn, soybeans, small grains, and alfalfa. Small grains and the first cutting of alfalfa are generally the better suited crops because they grow and mature in the spring when there is more rainfall. Soil blowing is a hazard. Starting crops on this soil is sometimes difficult because soil blowing destroys young seedlings early in the spring. Soil blowing can be reduced, moisture conserved, and the organic matter content and fertility maintained by using a cropping system that keeps the soil surface covered with crops, grass, or crop residue.

Under irrigation, this soil is suited to corn, soybeans, small grains, alfalfa, and introduced grasses. Sprinkler irrigation is the only system suitable on this soil. Frequent applications of irrigation water are needed. Because the available water capacity is low, frequent light applications of water are needed to avoid excessive leaching of plant nutrients. Returning crop residue to the soil and using barnyard manure help to increase the organic matter content and improve fertility. Crop residue should be left on the surface to help control soil blowing.

This soil is well suited to rangeland, either grazing or haying. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights help to reduce the protective cover and cause deterioration of the native plants. Proper grazing use and timely deferment from grazing or haying help to maintain or improve the range condition.

This soil is suited to trees planted in windbreaks if soil blowing is controlled by maintaining strips of sod or other vegetation between the rows. Drought and competition for moisture from grasses and weeds are hazards. Supplemental moisture during dry periods can be provided by irrigation. Weeds and grasses can be controlled by cultivation or by timely use of appropriate herbicides.

This soil is generally suited to use as sites for small commercial buildings and dwellings without basements. If this soil is used for septic tank absorption fields, care should be taken so that seepage does not contaminate the underground water table. This soil readily absorbs effluent from septic tank absorption fields, but it does not adequately filter the effluent. Absorption fields can be constructed on fill material so that the absorption field can be placed a sufficient distance above the seasonal high water table. Sewage lagoons need to be lined or sealed to prevent seepage. They need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal high water table. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Buildings with basements need to be constructed on raised, well compacted fill material to overcome wetness caused by the high water table. Damage to roads by frost action can be reduced by providing good surface drainage and by use of a gravel moisture barrier in the subgrade.

This Ipage soil is in capability units IVe-5 dryland and IVe-11 irrigated. It is in the Sandy Lowland range site and windbreak suitability group 5.

ItB—Ipage-Tryon fine sands, 0 to 3 percent slopes. This complex consists of moderately well drained Ipage soil and very poorly drained Tryon soil. The Ipage soil is deep, nearly level to very gently sloping, and on low, convex sandy ridges. The Tryon soil is deep, nearly level, and in swales. The Tryon soil is rarely flooded, but it is occasionally ponded by water from a very high water table. Individual areas of this complex range from 10 to 1,000 acres. The complex is 45 to 60 percent Ipage soil and 30 to 40 percent Tryon soil. The two soils are so intricately mixed that it was not practical to separate them in mapping.

Typically, the Ipage soil has a surface layer of dark grayish brown, loose fine sand about 5 inches thick. The transitional layer is grayish brown, loose fine sand about 4 inches thick. The underlying material extends to a depth of more than 60 inches. It is light brownish gray fine sand in the upper part and light gray mottled sand in the lower part. In places, the surface layer is sand or loamy sand.

Typically, the Tryon soil has a surface layer of gray, loose fine sand about 4 inches thick. The underlying material is light gray mottled sand to a depth of more than 60 inches. In places, the surface layer is loamy fine sand. In a few places, the surface layer is 10 to 20 inches thick.

Included with these soils in mapping are small areas of Els, Marlake, and Valentine soils. Els soils are on the landscape between the Ipage and the Tryon soil and are somewhat poorly drained. Marlake soils are in the lowest

positions on the landscape and have a higher seasonal water table than the Tryon soil. Valentine soils are higher on the landscape and are excessively drained. Also included are areas of Tryon soils that are poorly drained. Included soils make up 5 to 10 percent of the complex.

Permeability is rapid and the available water capacity is low in both the Ipage and Tryon soils. The organic matter content is low in the Ipage soil and high in the Tryon soil. Natural fertility is low in both soils. The Ipage soil is medium acid to neutral, and the Tryon soil is slightly acid to moderately alkaline. Runoff is very slow. The seasonal high water table in the Ipage soil ranges from a depth of about 3 feet in wet years to about 6 feet in dry years. The seasonal high water table in the Tryon soil ranges from 0.5 foot above the surface in wet years to a depth of about 1 foot in dry years. The Tryon soil sometimes has water over the surface for a week or two in the spring and during other wet periods.

Most of the acreage of this complex is in native grass and is used as rangeland.

This complex is unsuited to cropland because of droughtiness and the hazard of soil blowing on the Ipage soil and ponding caused by the seasonal high water table on the Tryon soil.

This complex is suited to rangeland. Overgrazing by livestock, improper timing of haying, or improper mowing heights can cause deterioration of the native plants. If the Tryon soil is wet, overgrazing can cause surface compaction and small mounds, making it difficult to graze or harvest for hay. Proper grazing use, timely deferment from grazing or haying, and restricted use during very wet periods help to maintain the native plants in good condition.

The Ipage soil is suited to trees planted in windbreaks. The Tryon soil is unsuited to trees because of wetness. Onsite investigations are needed to select suitable sites for windbreaks. Soil blowing and droughtiness are problems on the Ipage soil. Trees need to be planted in a shallow furrow with as little disturbance of the soil as possible. Irrigation can provide supplemental water during times of insufficient moisture. Competition from weeds and undesirable grasses can be controlled by maintaining strips of sod between the rows and in the rows. Areas around the trees can be hoed by hand.

The Ipage soil is the only part of this complex suited to septic tank absorption fields. Absorption fields can be constructed on fill material so that the absorption field can be placed a sufficient distance above the seasonal high water table. This Ipage soil readily absorbs effluent from septic tank absorption fields, but it does not adequately filter the effluent. Care should be taken so that seepage does not contaminate the underground water table. The Tryon soil is not suited to septic tank absorption fields because of wetness.

Sewage lagoons need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal high water table. Sewage lagoons need to be lined or sealed to prevent seepage and diked as protection against ponding. The walls or sides of shallow excavations in the Ipage soil can be temporarily shored to prevent sloughing or caving. The Ipage soil is generally suited to buildings without basements and small commercial buildings. Buildings with basements need to be constructed on raised, well compacted fill material to overcome wetness caused by the high water table. The Tryon soil is not suitable for building sites because of wetness and ponding. Constructing roads on suitable, well compacted fill material above the ponding level and providing adequate side ditches and culverts help to protect roads from damage by ponding and wetness from the seasonal water table. Damage to roads by frost action can be reduced by providing good surface drainage and by the use of a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. Before using areas of this complex for any engineering purposes, onsite investigation should be made.

This complex is in capability unit VIe-5 dryland. The Ipage soil is in the Sandy Lowland range site and windbreak suitability group 7. The Tryon soil is in the Wetland range site and windbreak suitability group 10.

Jn—Jansen loam, 0 to 2 percent slopes. This soil is moderately deep over gravelly coarse sand. It is nearly level, well drained, and on uplands. Individual areas range from 5 to several thousand acres.

Typically, the surface layer is dark gray, friable loam about 6 inches thick. The subsurface layer is similar to the surface layer in color and texture and is about 6 inches thick. The subsoil is about 18 inches thick. The upper part of the subsoil is dark grayish brown, friable loam; the middle part is brown, firm loam and sandy clay loam; and the lower part is light yellowish brown, very friable loamy coarse sand. The underlying material to a depth of more than 60 inches is very pale brown gravelly coarse sand. In places, the surface layer is sandy loam. In a few places, loamy material or sand is below a depth of 30 inches.

Included with this soil in mapping are small areas of Anselmo, Meadin, and O'Neill soils. Anselmo soils are on the higher parts of the landscape and contain more sand in the subsoil. The Meadin soils generally are lower on the landscape, and the depth to gravelly coarse sand is less than 20 inches. The O'Neill soils have more sand in the subsoil and are on similar landscapes. Included soils make up 5 to 15 percent of this map unit.

Permeability of this Jansen soil is moderate in the solum and very rapid in the underlying gravelly coarse sand. The available water capacity is moderate, and natural fertility is medium. The organic matter content is moderate. The water intake rate is moderate. The soil is

strongly acid to neutral. Runoff is slow. This soil is easily tilled.

Most of the acreage of this soil is used as dryland and irrigated cropland. The rest is in native grass and is used as range or hayland.

Under dryland farming, this soil is suited to small grains, corn, sorghum, soybeans, and alfalfa. Corn is not well suited because the underlying gravelly coarse sand makes the soil droughty. Small grains and the first cutting of alfalfa are generally the most dependable crops because they grow and mature in spring when rainfall is the highest. Stubble mulch tillage and a cropping system that keeps the soil covered with crops or crop residue most of the year conserve moisture and reduce the hazard of soil blowing. Additions of barnyard manure improve fertility.

Under irrigation, this soil is suited to corn, soybeans, sorghum, and alfalfa. Furrow and border irrigation are effective in areas where land leveling is practical. Deep cuts should be avoided in order to prevent exposing the coarse underlying material. Sprinkler irrigation systems are suited. Because of the very low moisture retention in the underlying coarse material, crops show the effects of drought if irrigation is not timely. Plant nutrients can be leached from this soil; therefore, the application of water should be carefully managed. Returning crop residue to the soil and applying barnyard manure help to maintain the fertility.

This soil is suited to rangeland. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. Only those trees and shrubs that are tolerant of drought are suited. Moisture competition from grasses and weeds and droughty conditions are the principal hazards to seedling establishment. Supplemental moisture needs to be provided by irrigation during extended dry periods. Cultivation between the rows and timely use of herbicides can control undesirable grasses and weeds. Weeds next to the trees can be rototilled or hoed by hand.

This soil is generally suited to dwellings with basements. If this soil is used for septic tank absorption fields, care should be taken so that seepage does not contaminate nearby water supplies. This soil readily absorbs effluent from septic tank absorption fields, but it does not adequately filter the effluent. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Foundations for buildings without basements need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarse grained material for subgrade or base material can be used to ensure better performance.

This Jansen soil is in capability units IIs-5 dryland and IIs-7 irrigated. It is in the Silty range site and windbreak suitability group 6G.

JnC—Jansen loam, 2 to 6 percent slopes. This soil is moderately deep over gravelly coarse sand. It is gently sloping, well drained, and on upland side slopes. Individual areas range from 5 to 500 acres.

Typically, the surface layer is dark gray, very friable loam about 8 inches thick. The subsurface layer is dark grayish brown, friable loam about 3 inches thick. The subsoil is about 19 inches thick. It is grayish brown, friable loam in the upper part and pale brown, friable sandy clay loam in the lower part. The underlying material is pale brown, gravelly coarse sand to a depth of more than 60 inches. In places, the surface layer is silt loam or sandy loam. In some areas, erosion has removed the original darkened surface layer and in places part of the subsoil. In some areas, the surface layer is clay loam or sandy clay loam.

Included with this soil in mapping are small areas of Anselmo, Meadin, and O'Neill soils. Anselmo soils are on the lower parts of the landscape and are sandier throughout. O'Neill soils are on similar landscape positions and have more sand in the subsoil. Meadin soils are on ridgetops or shoulders along drainageways and have gravelly coarse sand at depths of 8 to 20 inches. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Jansen soil is moderate in the solum and very rapid in the gravelly coarse sand. The available water capacity is moderate. The organic matter content is moderate, and natural fertility is medium. The soil is strongly acid to neutral. Runoff is medium. This soil is easily worked.

Areas of this soil are used as cropland or rangeland.

Under dryland farming, this soil is suited to corn, soybeans, small grains, and alfalfa. Corn is not well suited because of the droughty conditions of the soil. Small grains and the first cutting of alfalfa are most dependable because they grow and mature in spring when rainfall is highest. The soil is subject to water erosion and soil blowing. A cropping system that keeps the soil surface covered with crops or crop residue most of the time conserves moisture and helps to control water erosion and soil blowing. Adding barnyard manure improves the organic matter content and fertility.

Under irrigation, this soil is suited to corn, soybeans, sorghum, alfalfa, and introduced grasses. Sprinkler irrigation systems are best suited to this soil. Water needs to be applied slowly to control runoff and avoid leaching plant nutrients below the root zone. Land

leveling is required for gravity irrigation systems. Deep cuts made in land leveling operations can expose the underlying gravelly coarse sand. Terraces, grassed waterways, contour farming, and the use of crop residue as mulch reduce runoff and erosion. Returning crop residue to the soil and using barnyard manure help to increase the organic matter content and fertility.

This soil is suited to rangeland. This use is effective in controlling soil blowing and water erosion. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to growing trees in windbreaks. Only those trees and shrubs that tolerate droughty conditions are suited. The competition for moisture from grasses and weeds and the droughty condition are the main hazards to the establishment of seedlings. In places, irrigation is necessary for successful establishment of trees. Weeds and undesirable grasses can be controlled by cultivating with conventional equipment or by timely use of the appropriate herbicides. Areas near the trees can be rototilled or hoed by hand.

This soil is generally suited to dwellings with basements. If this soil is used for septic tank absorption fields, care should be taken so that seepage does not contaminate nearby water supplies. This soil readily absorbs effluent from septic tank absorption fields, but it does not adequately filter the effluent. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Foundations for buildings without basements need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Small commercial buildings need to be properly designed to accommodate the slope, or the soil can be graded to an acceptable gradient. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarse grained material for subgrade or base material can be used to ensure better performance.

This Jansen soil is in capability units IIIe-1 dryland and IIIe-7 irrigated. It is in the Silty range site and windbreak suitability group 6G.

JsC—Jansen-Meadin loams, 3 to 6 percent slopes. This complex consists of well drained Jansen soil that is moderately deep over gravelly coarse sand and excessively drained Meadin soil that is shallow over gravelly coarse sand. These soils are gently sloping and on side slopes along drainageways that drain to the Niobrara River. Areas range from 50 to 700 acres. The complex is about 65 to 75 percent Jansen soil and about 15 to 25 percent Meadin soil. The Jansen soil is on the concave, mid and lower part of the slopes, and the Meadin soil is on the convex shoulders and narrow ridgetops. The soils are so intricately mixed that it was not practical to separate them in mapping.

Typically, the Jansen soil has a dark gray, friable loam surface layer about 11 inches thick. The subsoil is about 19 inches thick. It is dark grayish brown, very friable loam in the upper part and brown, friable sandy clay loam in the lower part. The underlying material is very pale brown, gravelly coarse sand to a depth of more than 60 inches. In places, the surface layer is silt loam or fine sandy loam.

Typically, the Meadin soil has a dark grayish brown, friable loam surface layer about 8 inches thick. The transitional layer is grayish brown, very friable gravelly sandy loam about 8 inches thick. The underlying material is pale brown gravelly coarse sand to a depth of more than 60 inches. In places, the surface layer is loamy sand or fine sandy loam. In a few places, the gravelly coarse sand is at the surface.

Included with these soils in mapping are small areas of Anselmo, O'Neill, and Paka soils. These soils occupy similar positions on the landscape. Anselmo and O'Neill soils are sandier throughout. The Paka soil has finer textured underlying material. Included soils make up 10 to 15 percent of the complex.

Permeability in the Jansen soil is moderate in the subsoil and very rapid in the underlying material. Permeability in the Meadin soil is rapid in the upper part and very rapid in the lower part. The available water capacity is moderate in the Jansen soil and low in the Meadin soil. The Jansen soil has moderate organic matter content and medium natural fertility. The Meadin soil has moderately low organic matter content and low natural fertility. Runoff is medium. Both soils are strongly acid to neutral.

This complex is mostly in native grass that is used as range. A few areas are used as irrigated cropland.

Under dryland farming, this complex is poorly suited to corn, soybeans, alfalfa, small grains, and introduced grasses. The first cutting of alfalfa and small grains are normally most dependable because these crops grow and mature in spring when rainfall is highest. Growth of crops is spotty in areas of this complex because crops growing on areas of the droughty Meadin soil are usually very poor. The soils of this complex are so intermixed they cannot be managed separately. The main hazards are soil blowing and water erosion. Alternating row crops with small grains and keeping the soil covered with crops or crop residue reduce erosion and help to conserve moisture. Adding barnyard manure to the soil increases the organic matter content and improves fertility.

Under sprinkler irrigation, this complex is suited to introduced grasses or small grains. Corn, alfalfa, and soybeans can be grown, but growth of crops may be spotty if irrigation is not timely. Sprinkler irrigation is the only method suitable for these soils. Water needs to be applied lightly and frequently to avoid leaching plant

nutrients below the root zone. Soil blowing and water erosion are hazards when these soils are used for irrigated croplands. A cropping system that keeps the soil covered with crops or crop residue needs to be used. Returning crop residue and barnyard manure to the soil increases the organic matter content and improves fertility.

This complex is suited to rangeland. This use is effective in controlling soil blowing and water erosion. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve the range condition.

The Jansen soil is suited to trees planted in windbreaks. Only those trees and shrubs that are tolerant of droughty conditions are suited. Moisture competition from grasses and weeds and the low available water holding capacity are the principal hazards to seedlings. Irrigation may be needed for successful establishment of trees. Weeds and undesirable grasses can be controlled by cultivation and by timely use of appropriate herbicides. The Meadin soil is generally unsuited to trees because of its shallow depth and low available water holding capacity. Growth of trees is not uniform in areas of these soils. Careful site selection is important.

These soils are generally suited to dwellings with basements. If these soils are used for septic tank absorption fields, care should be taken so that seepage does not contaminate nearby water supplies. These soils readily absorb the effluent from absorption fields, but they do not adequately filter the effluent. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. On the Jansen soil, foundations for buildings without basements need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Small commercial buildings need to be properly designed to accommodate the slope, or the soil can be graded to an acceptable gradient. Because the Jansen soil has low strength, roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarser grained material for subgrade or base material can be used to ensure better performance. The Meadin soil is suited to use for roads and streets.

This complex is in capability units IVs-4 dryland and IVs-14 irrigated. The Jansen soil is in the Silty range site and windbreak suitability group 6G. The Meadin soil is in the Shallow to Gravel range site and windbreak suitability group 10.

Jt—Josburg fine sandy loam, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is on uplands. Individual areas range from 5 to 300 acres.

Typically, the surface layer is grayish brown, very friable fine sandy loam about 6 inches thick. The subsurface layer is brown, very friable fine sandy loam about 4 inches thick. The subsoil is about 38 inches thick. It is yellowish brown, very friable fine sandy loam in the upper part; pale brown, firm clay loam in the middle part; and very pale brown, firm, calcareous clay loam in the lower part. The underlying material is very pale brown sandy clay loam. In a few places, the surface layer is loam, sandy loam, or loamy sand. In places, the underlying material is sandy clay, silty clay loam, or gravelly sandy clay loam. In a few places, coarse sand and gravelly coarse sand are below a depth of 48 inches.

Included with this soil in mapping are small areas of Anselmo, Dunn, Jansen, and O'Neill soils. Anselmo soils are higher on the landscape and contain more sand in the lower part. Dunn soils are higher on the landscape and contain more sand in the upper part. Jansen and O'Neill soils are moderately deep over gravelly coarse sand and are in similar positions on the landscape. Included soils make up 10 to 15 percent of the map unit.

This Josburg soil has moderate permeability in the upper part of the profile and slow permeability in the lower part. The organic matter content is moderate, and natural fertility is medium. The available water capacity is high. The soil ranges from very strongly acid to mildly alkaline. Runoff is slow, and the water intake rate is slow. The slowly permeable subsoil can cause this soil to stay wet longer in the spring than adjacent areas of soils, especially in low areas or swales.

Most of the acreage of this soil is farmed. A large percent is irrigated. The remaining acreage is in native grass.

Under dryland farming, this soil is suited to corn, sorghum, soybeans, small grains, alfalfa, and introduced grasses. Soil blowing is a hazard where the surface is not adequately protected by growing crops or crop residue. Planting and tillage operations can be delayed in some places in the spring because of wetness. Conservation tillage practices, such as chiseling or discing and stubble mulch tillage, help to prevent soil blowing during spring and fall months and conserve soil moisture. Returning crop residue and adding barnyard manure to the soil help to maintain and increase organic matter content and improve fertility.

Under irrigation, this soil is suited to corn, sorghum, soybeans, alfalfa, and introduced grasses. It can be irrigated with sprinkler or gravity irrigation systems; however, land leveling is needed for gravity irrigation. In places, land leveling operations can expose some of the subsoil material at the surface, and this material is difficult to cultivate. Irrigation can be infrequent, and slow

heavy applications of water can be used. Overirrigating can cause water to pond in low areas and swales. Because this soil is slow to dry out following heavy rains, tillage operations can be delayed, especially in the spring. Soil blowing can be reduced by keeping the soil covered with crops or crop residue. Returning crop residue to the soil increases the organic matter content and fertility.

This soil is suited to rangeland. This use is very effective in controlling soil blowing. Overgrazing the range reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees planted in windbreaks. Only trees and shrubs that are tolerant of somewhat droughty conditions are suited. Inadequate moisture and severe soil blowing are principal hazards in the establishment of trees. Irrigation can provide supplemental water during dry periods. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the rows. Competition from weeds and undesirable grasses can be controlled by cultivating or using appropriate herbicides.

Septic tank absorption fields are not suited to this soil because of slow permeability. A suitable alternate site is needed. Sewage lagoons need to be lined or sealed to prevent seepage. This soil is generally suited to shallow excavations. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. The base material for roads and streets can be mixed with additives, such as hydrated lime, to help prevent shrinking and swelling. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarser grained material for subgrade or base material can be used to ensure better performance.

This soil is in capability units IIe-3 dryland and IIe-8 irrigated. It is in the Sandy range site and windbreak suitability group 5.

Jw—Josburg loam, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is on uplands. Individual areas range from 5 to 400 acres.

Typically, the surface layer is dark gray, very friable loam about 7 inches thick. The subsurface layer is dark grayish brown, very friable loam about 6 inches thick. The subsoil is about 29 inches thick. It is grayish brown, friable loam in the upper part; brown, friable sandy clay loam in the middle part; and yellowish brown and pale brown, firm sandy clay loam in the lower part. The underlying material is very pale brown and calcareous to a depth of more than 60 inches. It is sandy clay loam in the upper part and fine sandy loam in the lower part. In places, the surface layer is silt loam or fine sandy loam. In places, the underlying material is sandy clay, silty clay loam, or gravelly sandy clay loam. In places, the underlying material is stratified with material of sandy texture. In a few places, gravelly coarse sand is below a depth of 48 inches.

Included with this soil in mapping are small areas of Anselmo, Jansen, O'Neill, and Paka soils. Anselmo soils contain more sand and are higher on the landscape. Jansen, O'Neill, and Paka soils are in similar landscape positions. Jansen and O'Neill soils are underlain by gravelly coarse sand at a depth of 20 to 40 inches. Paka soils are more friable. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Josburg soil is moderate in the upper part of the profile and slow in the lower part. The available water capacity is high. The organic matter content is moderate, and natural fertility is medium. The water intake rate for irrigation is moderate. Runoff is slow. This soil is slow to dry out following heavy rains. This soil is very strongly acid to moderately alkaline.

Most of the acreage of this soil is farmed, and much of it is irrigated. The remaining acreage is in native grass and is used mostly as rangeland.

Under dryland farming, this soil is suited to corn, soybeans, sorghum, small grains, and alfalfa. Small grains and first cutting alfalfa are generally the most dependable crops because they grow and mature in spring when rainfall is usually highest. This soil dries out slowly in the spring, and wetness in low areas can delay planting and tillage operations. Soil blowing is a hazard where the surface is not adequately protected by growing crops or crop residue. Conservation tillage practices, such as discing or chiseling and stubble mulch tillage, help to control soil blowing and conserve soil moisture. Returning crop residue to the soil and adding barnyard manure helps to increase the organic matter content and fertility.

Under irrigation, this soil is suited to corn, soybeans, sorghum, alfalfa, and introduced grasses. This soil absorbs moisture slowly and releases it slowly to plants. It is desirable that the entire profile be moist when the irrigation season begins. Irrigation can be infrequent, and relatively slow, heavy applications of water can be used. Care must be taken not to over irrigate so that the water stands in the low areas. This soil is suited to gravity and sprinkler irrigation methods. Some land grading is needed for gravity irrigation. Returning crop residue to the soil and using stubble mulch tillage practices increase the organic matter content and intake rate of the soil. Tillage practices that keep the soil covered with crop residue help to conserve soil moisture.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. Trees and shrubs that are moderately drought resistant are suited. Trees need to be watered during extended dry periods. Moisture competition from grasses and weeds is the principal hazard. Weeds and undesirable grasses between the tree rows can be controlled by cultivation. Appropriate herbicides can be used to control them in the tree row.

Septic tank absorption fields are not suited to this soil because of slow permeability. A suitable alternate site is needed. Sewage lagoons need to be lined or sealed to prevent seepage. This soil is generally suited to use for shallow excavations. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. The base material for roads and streets can be mixed with additives, such as hydrated lime, to help prevent shrinking and swelling. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarser grained material for the subgrade or base material can be used to ensure better performance.

This Josburg soil is in capability units IIc-1 dryland and I-2 irrigated. It is in the Silty range site and windbreak suitability group 3.

LaC—Labu silty clay, 2 to 6 percent slopes. This gently sloping, well drained soil is on uplands and foot slopes. It is moderately deep over dark, bedded shale. Individual areas are somewhat irregular in shape and range from 10 to 100 acres.

Typically, the surface layer is dark grayish brown silty clay about 5 inches thick. The subsoil is firm, calcareous silty clay about 23 inches thick. It is grayish brown in the upper part and light brownish gray in the lower part. The underlying material, about 10 inches thick, is calcareous, light gray shaly clay. Bedded shale is at a depth of 38 inches. In places, the surface layer is sandy clay or sandy clay loam. In places, the surface layer is 5 to 20 inches thick. In places, the bedded shale is below a depth of 40 inches.

Included with this soil in mapping are small areas of Paka, Sansarc, and Wewela soils. The Paka soils are in similar positions and are deep over siltstone. The Wewela soils are in similar positions and have a sandy or loamy surface layer. Sansarc soils are on ridges or knolls and have shale closer to the surface. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Labu soil is slow. The available water capacity is low. The organic matter content is moderately low, and natural fertility is low. The soil is mildly alkaline or moderately alkaline. The water intake rate is very low. Runoff is medium. This soil is difficult to work and keep in good tilth. It puddles if tilled when wet.

Most of the acreage of this soil is in cultivated crops. Some small areas are in native grass and are used as rangeland.

Under dryland farming, this soil is suited to small grains, sorghum, corn, alfalfa, and introduced grasses. Small grains and first cutting of alfalfa are the most dependable crops because they grow and mature early in spring when rainfall is highest. Grain sorghum is better suited than corn because it can tolerate droughty conditions for a longer period. Because of the clayey surface texture, this soil absorbs water slowly, resulting in runoff, which can cause erosion. Terraces, contour farming, and the use of crop residue help to control water erosion. Discing and chiseling generally leave all or part of the crop residue on the surface. Growing grasses and legumes in the cropping system improves tilth and increases the organic matter content. Barnyard manure is needed to improve fertility and organic matter content.

Under irrigation, this soil is unsuited to crops because of the clayey texture and very low water intake rate.

This soil is suited to rangeland. This use is effective in controlling water erosion. Overgrazing by livestock, improper timing of haying, or improper mowing heights can cause deterioration of the native plants. Overgrazing can result in severe soil losses by water erosion. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve the range condition.

This soil is poorly suited to trees and shrubs planted in windbreaks. Growth of trees and shrubs is poor because of the high clay content. The recommended species are those that are extremely drought tolerant. The soil needs to be prepared when it is moist but not wet. Irrigation is needed to provide additional moisture during dry periods. A light cultivation and supplemental water will close the cracks. Trees can be planted on the contour to prevent excessive runoff and erosion. Cultivation with conventional equipment and timely use of herbicides can control undesirable weeds and grasses.

Septic tank absorption fields are not suited to this soil because of slow permeability. A suitable alternate site is needed. Sewage lagoons can be constructed on areas of this soil if, after excavation, the bottom of the lagoon is sealed to prevent seepage. Digging is best done when the soil is not wet. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarser grained material for subgrade or base material can be used to ensure better performance. The base material for roads and streets can be mixed with additives, such as hydrated lime, to help prevent shrinking and swelling.

This Labu soil is in capability unit IIIe-4 dryland. It is in the Clayey range site and windbreak suitability group 4C.

LaD—Labu silty clay, 6 to 11 percent slopes. This well drained, strongly sloping soil is mostly on upland

side slopes. It is moderately deep over dark, bedded shale. Individual areas range from 20 to 100 acres.

Typically, the surface layer is dark grayish brown, firm silty clay about 4 inches thick. The subsoil is calcareous, very firm silty clay about 21 inches thick. It is olive brown in the upper part and light olive brown in the lower part. The underlying material, about 7 inches thick, is light brownish gray and olive yellow, calcareous shaly clay. Light brownish gray and olive yellow bedded shale is at a depth of about 32 inches. In places, the surface layer is 5 to 10 inches thick. In places, the bedded shale is below a depth of 40 inches.

Included with this soil in mapping are small areas of Wewela and Sansarc soils. Wewela soils are in similar positions on the landscape and have a sandy or loamy surface layer. The Sansarc soils are shallow over dark, bedded shale and are on the narrow, convex shoulders and ridgetops. Included soils make up 5 to 15 percent of this map unit.

Permeability of this Labu soil is slow. The available water capacity is low. The organic matter content is moderately low, and natural fertility is low. The soil ranges from neutral to moderately alkaline. It takes in water slowly and releases it slowly to plants. The shrink-swell potential is high. Runoff is medium or rapid. This soil is difficult to work and to keep in good tilth because it puddles if worked when the soil is too wet.

The acreage of this soil is used about equally as cropland and rangeland.

Under dryland farming, this soil is poorly suited to cropland. Small grains, sorghum, and alfalfa are the main crops. Water erosion is a hazard. A cropping system that uses terraces and contour farming along with the use of crop residue helps to control erosion. A grass cover helps to keep natural drainageways from eroding. Growing grasses and legumes in the cropping system about half the time improves tilth and increases the organic matter content.

Under irrigation, this soil is unsuited to crops because of the clayey texture and slope.

This soil is suited to rangeland. This use is effective in controlling water erosion. Overgrazing by livestock, improper timing of haying, or improper mowing heights cause deterioration of the native plants. Overgrazing can also result in severe soil losses by water erosion. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve the range condition.

This soil provides a poor site for trees and shrubs planted in windbreaks. Because of the high clay content, soil preparation should be done when the soil is moist but not wet. Growth of trees and shrubs on this soil is poor because of the high clay content. Recommended species are limited to those that are extremely drought tolerant. A light cultivation and application of supplemental water will close the cracks and protect the roots. Trees can be planted on the contour to prevent excessive runoff and erosion. Cultivation with conventional equipment and the timely use of appropriate herbicides can control weeds.

Septic tank absorption fields are not suited to this soil because of slow permeability. A suitable alternate site is needed. Sewage lagoons can be constructed on areas of this soil if, after excavation, the bottom of the lagoon is sealed to prevent seepage. Grading is required to modify the slope and shape the lagoon. Digging is best done when the soil is moist but not wet. Slope increases the difficulty of digging. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarse grained material for subgrade or base material can be used to ensure better performance. The base material for roads and streets can be mixed with additives, such as hydrated lime, to prevent shrinking and swelling.

This Labu soil is in capability unit IVe-4 dryland. It is in the Clayey range site and windbreak suitability group 4C.

LcF—Labu-Sansarc silty clays, 11 to 30 percent slopes. This complex consists of moderately deep and shallow soils over dark clay shales. These well drained, moderately steep and steep soils are on upland ridges and side slopes. Most areas are dissected by drainageways. The moderately deep Labu soil makes up 55 to 65 percent of this complex, and the shallow Sansarc soil makes up 20 to 30 percent. The Labu soil is on the long, lower, smooth slopes, and the Sansarc soil is on the short, steep slopes of ridgetops and on the shoulders of drainageways. Areas of this complex range from 60 to more than 1,000 acres. The two soils are so intricately mixed that it was not practical to separate them in mapping.

Typically, the Labu soil has a dark grayish brown, firm silty clay surface layer about 5 inches thick. The subsoil is light olive brown, firm silty clay about 15 inches thick. The lower part is calcareous. The underlying material, about 4 inches thick, is light olive brown, calcareous shaly clay. Light yellowish brown, calcareous bedded shale is at a depth of about 24 inches. In places, the surface layer is silt loam.

Typically, the Sansarc soil has a dark grayish brown, calcareous, firm, silty clay surface layer about 4 inches thick. The underlying material, about 8 inches thick, is pale brown, calcareous shaly clay. Pale brown and light yellowish brown, calcareous bedded shale is at a depth of about 12 inches.

Included with these soils in mapping are small areas of Paka, Verdel, and Wewela soils. Paka soils formed in siltstone sediment on steep side slopes or ridgetops. Wewela and Verdel soils are on lower side slopes and terrace positions along drainageways. Wewela soils have a loamy surface layer. Verdel soils have a thicker surface

layer. In a few places, sandstone fragments ranging from a few inches to 2 or 3 feet in diameter are on the surface. In places, the ridgetops are capped with a thin layer of gravel. Included soils make up 10 to 15 percent of the complex.

Permeability is slow for both the Labu and Sansarc soils. The available water capacity is low for the Labu soil and very low for the Sansarc soil. Natural fertility is low in both soils. The organic matter content is moderately low in both soils. Both soils range from neutral to moderately alkaline. These soils have a fine, plastic clay that holds some of the soil moisture under too much tension to be extracted by plant roots. They shrink and swell markedly upon wetting and drying. The soil has cracks 1 to 3 inches wide when dry. The root zone extends to bedded shale. Runoff is medium to very rapid.

Almost all of this complex is in native grass and is used as rangeland.

This complex is unsuited to cropland.

This complex is suited to rangeland. The major problems of range management are related to the hazard of erosion and droughtiness. The soils are somewhat droughty because of the low available water capacity and water losses by runoff. Management that maintains an adequate vegetative cover and ground mulch helps to prevent excessive soil losses and improves the moisture supply by reducing runoff. Overgrazing by livestock reduces the protective vegetative cover and causes deterioration of the native plants. Under these conditions the taller, more desirable grasses are replaced by the less productive short grasses. Proper grazing use, timely deferment of grazing, and a planned grazing system help to maintain or

Figure 14.—Dams, constructed in drainageways in areas of Labu-Sansarc silty clays, 11 to 30 percent slopes, provide water for livestock and for recreation uses.

improve the range condition. Livestock wells are difficult to obtain, but potential pond reservoir sites are plentiful (fig. 14).

The Labu soil is poorly suited to trees and shrubs planted in windbreaks. The Sansarc soil is generally not suited. Because of the high clay content, soil preparations need to be done when the soil is moist but not wet. Growth of trees and shrubs is poor. Species are limited to those that are extremely drought tolerant. A light cultivation and irrigation will close the cracks and protect the roots. Trees can be planted on the contour to reduce runoff and erosion. Cultivation with conventional equipment and timely use of herbicides control weeds and undesirable grasses.

These soils are generally not suitable for sanitary facilities because of the steep slopes, slow permeability, and the shallow depth to bedrock of the Sansarc soil. A suitable alternate site is needed. Roads need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarse grained material for subgrade or base material can be used to ensure better performance. Cuts and fills are generally needed to provide a suitable grade for roads. The base material for roads and streets can be mixed with additives, such as hydrated lime, to help prevent shrinking and swelling.

This complex is in capability unit VIe-4 dryland. The Labu soil is in the Clayey range site and windbreak suitability group 4C. The Sansarc soil is in the Shallow Clay range site and in windbreak suitability group 10.

Ld—Lamo-Lute loams, 0 to 2 percent slopes. These deep, nearly level, somewhat poorly drained soils are on bottom lands. Typically, about 55 to 70 percent of the complex is Lamo soil and 15 to 30 percent is Lute soil. These soils are in similar positions on the landscape and are so intricately mixed it was not practical to separate them in mapping. Areas of Lute soil are irregular in shape and range from about 10 to 200 feet across. They are surrounded by the larger areas of Lamo soil. Areas of this complex are rarely flooded. Individual areas range from about 40 to 250 acres.

Typically, the Lamo soil has a very dark gray, friable loam surface layer about 9 inches thick. The subsurface layer is dark gray and gray, firm, calcareous silty clay loam about 18 inches thick. The transitional layer is gray, firm, calcareous silty clay loam about 7 inches thick. The underlying material is light brownish gray, mottled, calcareous sandy clay loam to a depth of 43 inches. Extending to a depth of more than 60 inches is mottled coarse sand that is light brownish gray in the upper part and pale brown in the lower part. In places, the pedon contains strata of silty clay. In places, the soil profile lacks free carbonates. In a few places, the coarse sand is at a depth of less than 40 inches.

Typically, the Lute soil has a surface layer of gray, calcareous, friable loam about 2 inches thick. The subsoil is about 25 inches thick. It is dark gray, firm, calcareous loam in the upper part and gray, firm, calcareous fine sandy loam in the lower part. The underlying material is mottled, light gray sand to a depth of more than 60 inches. In places, the underlying material is stratified with coarse sand to sandy clay loam textures.

Included with these soils in mapping are small areas of Lex and Gannett soils. Lex soils are in similar positions on the landscape and have a thinner surface layer. Gannett soils are poorly drained or very poorly drained and are lower on the landscape. Included soils make up 10 to 15 percent of this complex.

Permeability is moderately slow in the Lamo soil. Permeability in the Lute soil is slow in the subsoil and rapid in the underlying material. The available water capacity is high in the Lamo soil and moderate in the Lute soil. The organic matter content is moderate in the Lamo soil and moderately low in the Lute soil. Natural fertility is medium in the Lamo soil and low in the Lute soil. Runoff is slow to very slow, and some areas of Lute soil in microdepressions are ponded. The Lamo soil is neutral to moderately alkaline. The Lute soil is neutral to very strongly alkaline. The Lute soil is high in sodium content. The seasonal high water table ranges from a depth of 2 feet in wet years to about 3 feet in dry years on both soils. The Lamo soil has a moderately low water intake rate. The Lute soil takes in water slowly. The Lute soil becomes very hard when dry.

A large part of this complex is used as cropland. Some of the cropland is irrigated. The rest of the complex is in native grass and is used as rangeland.

Under dryland farming, this complex is poorly suited to corn, sorghum, small grains, alfalfa, and alkali-tolerant grasses. Growth of crops is spotty. These soils are slow to dry out in the spring, and tillage operations are usually delayed. The Lamo soil is suited to most crops grown in the county, but the Lute soil is intermixed with the Lamo soil and they must be managed together. The areas of Lute soil are hard and cloddy when dry. The Lute soil tends to stay wet longer than the areas of the Lamo soil, which causes problems with tillage and harvesting operations. Because of the high sodium content in the Lute soil, nutrients and moisture are not available to plants, and crop stands are usually poor. The high water table provides subirrigation during dry periods. Using legumes or grass-legume mixtures in the cropping system reduces the need for working the soil in the spring when it is wettest. Returning crop residue to the soil and large additions of barnyard manure, especially to the areas of Lute soil, increase the intake rate and improve the organic matter content and fertility.

Under irrigation, this complex is poorly suited to corn, alfalfa, sorghum, small grains, and alkali-tolerant grasses. Gravity and sprinkler irrigation systems are

suited. Some land grading or shaping is generally needed for gravity irrigation. The seasonal high water table is a problem in the spring and during wet periods. In the areas of the Lute soil, alkali is the main concern. The Lamo and Lute soils are intermixed and should be managed together. Wetness caused by the seasonal high water table delays tillage and planting operations in the spring. The Lute soil is normally hard and cloddy when dry and becomes very sticky when wet. Areas of Lute soil also stay wet longer than the adjacent areas of Lamo soil. The high sodium content in the Lute soil makes nutrients and moisture unavailable to plants. Usually there are poor stands of crops on Lute soil. Normally, tiling is not required for irrigation because the water table drops to a depth of 4 or 5 feet during summer in most years. Soil fertility can be improved by growing legumes and returning crop residue to the soil. Large additions of barnyard manure and other organic material to the areas of Lute soil help to increase the water intake rate and improve the organic matter content. Additions of chemicals are needed to neutralize the alkali in the Lute soil.

Reclamation of alkali soils is difficult, expensive, and time consuming. Technical help is needed before reclamation is begun, and the area needs to be fully investigated.

The alkaline Lute soil can be improved by adding chemical amendments, leaching the soil, and using practices that build soil structure. Soils should be tested to determine the kind and amount of chemical amendments needed. Many chemical amendments are available, but gypsum and sulphur are the most common. The common method of leaching is to pond water over the surface of the alkali area. The amount of leaching water that enters the soil determines how much salt is removed from the soil. Leaching will not be effective if the water table is too close to the surface. The water table should be 4.5 to 5.5 feet below the surface during the growing season. Heavy applications of barnyard manure and other forms of organic matter to the soil help to improve soil structure.

This complex is suited to rangeland, either grazing or haying. Overgrazing, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. When the soil is wet, overgrazing can cause surface compaction and small mounds, making it difficult to graze or harvest for hay. Proper grazing use, timely deferment, and a planned grazing system help to maintain or improve the range condition.

The Lamo soil is suited to trees and shrubs planted in windbreaks, but the Lute soil is poorly suited. Onsite investigations can be necessary to select the better suited areas. Only trees and shrubs that are tolerant of occasional wetness are suited to these soils. Establishment of seedlings can be a problem in wet years. The soil can be tilled and the seedlings planted after the soil is sufficiently dry. The effect of the alkali in the Lute soil can be minimized by using those species given for this soil in table 9. Competition from undesirable weeds and grasses can be controlled by cultivation between the rows with conventional equipment and by using appropriate herbicides. Areas in the row and close to the trees can be rototilled or hoed by hand.

Before areas of this complex are used for engineering purposes, onsite investigation is needed. Septic tank absorption fields can be constructed on fill material so that the absorption field can be placed a sufficient distance above the seasonal high water table. The moderately slow permeability of the Lamo soil is a limitation for septic tank absorption fields, but this can generally be overcome by increasing the size of the absorption field. Sewage lagoons need to be lined or sealed to prevent seepage. They need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal high water table. Digging in these soils during dry periods reduces wetness problems. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Dwellings and buildings need to be constructed on raised, well compacted fill material to overcome wetness caused by the high water table and as protection against flooding. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarser grained material for subgrade or base material can be used to ensure better performance. Damage to roads by frost action can be reduced by providing good surface drainage and by the use of a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This complex is in capability units IVs-1 dryland and IIIs-7 irrigated. The Lamo soil is in the Subirrigated range site and windbreak suitability group 2S. The Lute soil is in the Saline Subirrigated range site and windbreak suitability group 9S.

Lf—Lawet loam, drained, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on bottom lands. This soil is rarely flooded. Individual areas range from 5 to 300 acres.

Typically, the surface layer is calcareous, very dark gray, very friable loam about 8 inches thick. The subsurface layer is calcareous, gray, very friable loam about 8 inches thick. The underlying material extends to a depth of more than 60 inches. The upper part of the underlying material is light brownish gray, calcareous loam; the middle part is mottled, light gray, calcareous loam; and the lower part is mottled, light gray loam. In

places, the surface layer is fine sandy loam. In a few places, the underlying material is silty clay loam. In places, the underlying material has strata of clay loam or sandy loam. Dark buried layers are common below a depth of 20 inches.

Included with this soil in mapping are small areas of Gannett, Libory, Lex, and Ord soils. Gannett soils are poorly drained or very poorly drained and are lower on the landscape. Lex soils are in similar positions on the landscape and have sand or gravel at a depth of 20 to 40 inches. Libory soils are higher on the landscape and are better drained. Ord soils are on similar positions as Lawet soils, but they contain more sand. Included soils make up 10 to 15 percent of the map unit.

This Lawet soil has moderate permeability. The available water capacity is high. The organic matter content is moderate, and natural fertility is medium. The soil ranges from mildly alkaline to strongly alkaline in the upper part and from neutral to strongly alkaline in the underlying material. Runoff is slow. The seasonal high water table ranges from a depth of about 1.5 feet in wet years to about 3 feet in dry years. It normally recedes to a depth of about 3 to 6 feet or more by late in summer or early in fall.

Most of the acreage of this soil is in native grass and is used as rangeland or hayland. A small acreage is used as cropland.

Under dryland farming, this soil is suited to corn, sorghum, soybeans, small grains, and alfalfa. Wetness generally delays tillage and cultivation early in the spring. A cropping system that includes close-growing crops eliminates need for tillage in the spring. Returning crop residue to the soil increases the supply of organic matter. Soil fertility can be improved by using barnyard manure.

Under irrigation, this soil is suited to corn, sorghum, soybeans, and small grains. Land leveling is needed where gravity systems are used for irrigating. Leveling also improves surface drainage. Sprinkler irrigation is also suitable. Excessive application of irrigation water leaches plant nutrients below the plant roots. Normally, tiling is not required, but the water table can be controlled by using drainage ditches or tile drains. Finding suitable outlets for drainage systems can be a problem. Lowering the water table helps the soil to warm up earlier in spring and allows earlier tillage and planting.

This soil is suited to rangeland, either grazing or haying. Overgrazing, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and restricted use during wet periods help to maintain the native plants in good condition.

This soil is suited to trees planted in windbreaks. Only trees and shrubs that are tolerant of a high water table are suited. Establishment of seedlings can be a problem during wet years. The soil should be tilled and seedlings planted after the soil has begun to dry out. The abundant and persistent herbaceous vegetation that grows on this soil competes for moisture in the tree row. Weeds and grasses between the rows can be controlled by cultivation and appropriate herbicides. Areas near the trees can be rototilled or hoed by hand.

Septic tank absorption fields can be constructed on fill material so that the absorption field can be placed a sufficient distance above the seasonal high water table. The moderate permeability of this soil is a limitation for septic tank absorption fields, but this can generally be overcome by increasing the size of the absorption field. Sewage lagoons need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal high water table. Digging in this soil during dry periods reduces water problems. Dwellings and buildings need to be constructed on raised, well compacted fill material to overcome wetness caused by the high water table and as protection against flooding. Damage to roads by frost action can be reduced by providing good surface drainage and by the use of a good moisture barrier in the subgrade. Crowning the road by grading and constructing adequate side ditches help provide the needed drainage.

This Lawet soil is in capability units IIIw-4 dryland and IIIw-6 irrigated. It is in the Subirrigated range site and windbreak suitability group 2S.

Lg—Lawet-Lute complex, 0 to 2 percent slopes. These deep, nearly level, somewhat poorly drained soils are on bottom lands. Areas of this map unit are rarely flooded. Individual areas range from about 5 to 250 acres. The complex is 45 to 60 percent Lawet soil and 20 to 35 percent Lute soil. Areas of Lute soil are intermixed with Lawet soil and occupy similar positions on the landscape. Most areas of Lute soil are in spots 5 to 100 feet in diameter. Areas of Lute soil are irregular in size and shape and are surrounded by the larger areas of Lawet soil. The two soils are so intricately mixed that it was not practical to separate them in mapping.

Typically, the Lawet soil has a surface layer of dark gray, very friable loam about 10 inches thick. The subsurface layer is grayish brown, friable, calcareous loam about 6 inches thick. The underlying material extends to a depth of 60 inches. It is light gray, calcareous loam in the upper part and white, calcareous loam in the lower part and has faint reddish brown mottles. In places, the surface layer is fine sandy loam. In places, the underlying material is clay loam or silty clay loam.

Typically, the Lute soil has a gray, very friable fine sandy loam surface layer about 4 inches thick. The subsoil, about 18 inches thick, is firm, calcareous loam. The upper part of the subsoil is dark grayish brown, the middle part is grayish brown, and the lower part is pale brown. The underlying material is light gray and white, mottled, calcareous loam stratified with fine sandy loam

to a depth of more than 60 inches. In places, the lower part of the surface layer is fine sand or loamy fine sand. In a few places, the surface layer is more than 5 inches thick.

Included with these soils in mapping are small areas of Gannett, Lex, Libory, and Ord soils. Gannett soils are lower on the landscape and are poorly drained or very poorly drained. Lex and Ord soils are in similar positions on the landscape. Lex soils have coarse sand at a depth of 20 to 40 inches. Ord soils contain more sand. Libory soils are better drained and are slightly higher on the landscape. Included soils make up 10 to 15 percent of this complex.

Permeability in the Lawet soil is moderate. Permeability in the Lute soil is slow in the subsoil and moderate in the underlying material. The available water capacity is high in both soils. In the Lawet soil, the natural fertility is medium. In the Lute soil, the natural fertility is low. The organic matter content is moderate for Lawet soil and moderately low for Lute soil. Lute soil takes in water slowly and releases it slowly to plants. Runoff is slow or very slow, and some areas of Lute soil in microdepressions are ponded. The Lawet soil ranges from mildly alkaline to strongly alkaline throughout the profile. The Lute soil ranges from neutral to mildly alkaline in the upper part and from moderately alkaline to very strongly alkaline in the lower part. The Lute soil is high in content of sodium and other salts that influence the choice of crops. The seasonal high water table in both soils ranges from a depth of about 1.5 feet in wet years to about 3 feet in dry years. It recedes to a depth of 4 to 6 feet or more in places during midsummer.

Most of the acreage of this complex is in native grass and is used as rangeland or hayland. The rest of the acreage is used for cultivated crops under both dryland and irrigation management.

Under dryland farming, this complex is poorly suited to corn, soybeans, sorghum, and small grains. Alfalfa and alkali-tolerant grasses can be grown. Growth of crops is spotty. The main limitations are alkalinity problems and maintaining soil fertility. The Lute soil puddles if worked when too wet and becomes hard and cloddy when dry. The Lute soil is difficult to work and keep in good tilth. The seasonal high water table early in spring causes wetness that delays tillage and planting and causes the soil to warm up slowly. During dry periods, the water table provides subirrigation. Because of the sodium content, plant nutrients and moisture are not readily available in areas of Lute soil, and crop stands are poor. Soil blowing can be a problem during winter if the surface is unprotected. Using legumes or grass-legume mixtures in the cropping sequence reduces the need for tillage in the spring when the soils are wettest. Adding barnyard manure to the Lute soil increases the intake of moisture and improves tilth. Returning crop residue to the soil helps to increase the organic matter content and improve fertility.

Under irrigation, this complex is poorly suited to corn, alfalfa, and sorghum. Alkali-tolerant grasses can be grown. Crops do not grow so well on the Lute soil as on the Lawet soil. Alkali makes it difficult for crops to take up water, and the nutrients are not so readily available to the plants. In the areas of Lawet soil, the main concern is the seasonal high water table. Both soils are intermixed and must be managed as one unit. Furrow, border, and sprinkler methods of irrigation are suitable. Some grading is needed to provide better surface drainage and to get a more even distribution of irrigation water. Wetness, caused by the seasonal high water table, is a limitation because it delays tillage and planting early in the spring. Normally, tile drains or drainage ditches are not required for irrigation, but the water table is a concern of management during wet periods. Soil fertility can be improved by growing legumes, returning crop residue to the soil, and using barnyard manure. Additions of chemicals are needed to neutralize the alkali in the Lute soil.

Reclamation of alkali soils is difficult, expensive, and time consuming. Technical help is needed before reclamation is begun, and the area needs to be fully investigated.

The alkali condition can be improved by adding chemical amendments, leaching the soil, and using practices that build soil structure. Soils should be tested to determine the kind and amount of chemical amendments needed. Many chemical amendments are available, but gypsum and sulphur are the most common. The common method of leaching is to pond water over the surface of the alkali area. The amount of leaching water that enters the soil determines how much salt is removed from the soil. Leaching is not effective if the water table is too close to the surface. The water table should be 4.5 to 5 feet below the surface during the growing season. Heavy applications of barnyard manure and other forms of organic matter to the soil help to improve soil structure.

This complex is suited to rangeland, either grazing or haying. Overgrazing, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. In addition, when the soils are wet, overgrazing can cause surface compaction and small mounds, making it diffficult to graze or harvest for hay. Proper grazing use, timely deferment from grazing or haying, and restricted use during very wet periods help to maintain the native plants in good condition. Ranchers can usually make allowances as needed in the grazing usage and mowing patterns to fit the alkali soil conditions.

Mowing needs to be regulated so that the grasses remain vigorous if these soils are used as hayland. A proper mowing sequence should be followed. Grasses should be mowed before the seed is in the boot stage or after seed has matured. Mowing should be avoided between boot stage and seed maturity. After frost and

during winter, range animals can graze the meadows without damage if the areas are properly stocked.

The Lawet soil in this complex is suited to trees and shrubs planted in windbreaks; the Lute soil is poorly suited. Because of the intermixed composition of the soils, the soils must be treated as one unit. The capacity for survival and growth of adapted species is good in the Lawet soil and fair in the Lute soil. Onsite investigation is needed to select the most suitable windbreak sites. Only trees and shrubs that are tolerant of occasional wetness and alkali conditions are suited. In wet years, planting can be delayed until soils dry out. The effect of alkali can be minimized by using salt-tolerant species. Weeds and grasses can be controlled by cultivating between rows with conventional equipment. Appropriate herbicides can be applied in the tree rows, or the areas can be hoed by hand or rototilled.

Septic tank absorption fields can be constructed on fill material so that the absorption field can be placed a sufficient distance above the seasonal high water table. The moderate permeability in the Lawet soil is a limitation for septic tank absorption fields, but this can be overcome by increasing the size of the absorption field. Sewage lagoons in the Lute soil need to be lined or sealed to prevent seepage. They need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal high water table. Digging in these soils during dry periods is an easier operation and helps to avoid caving and water problems. Walls or sides of shallow excavations can be shored to prevent sloughing or caving. Dwellings and buildings need to be constructed on raised, well compacted fill material to overcome wetness caused by the high water table and as protection against flooding. Damage to roads by frost action can be reduced by providing good surface drainage and by the use of a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This complex is in capability units IVs-1 dryland and IIIs-6 irrigated. The Lawet soil is in the Subirrigated range site and windbreak suitability group 2S. The Lute soil is in the Saline Subirrigated range site and windbreak suitability group 9S.

Lh—Lex-Lute loams, 0 to 2 percent slopes. These nearly level, somewhat poorly drained soils are on bottom lands that are rarely flooded. The Lex soil is moderately deep over coarse sand. The Lute soil is deep. Typically, about 55 to 70 percent of the complex is Lex soil and 15 to 30 percent is Lute soil. These soils are in similar positions on the landscape. Areas of Lute soil are irregular in shape and range from 10 to 500 feet across. They are surrounded by the larger areas of Lex soil. The two soils are so intricately mixed it was not practical to separate them in mapping. Individual areas range from 10 to 500 acres.

Typically, the Lex soil has a very dark gray, friable, calcareous, loam surface layer about 5 inches thick. The subsurface layer is dark gray, friable, calcareous loam about 5 inches thick. The transitional layer is mottled, gray, firm, calcareous silty clay loam about 15 inches thick. The underlying material is mottled, grayish brown clay loam to a depth of 31 inches. Light gray coarse sand extends to a depth of 60 inches or more. In places, some layers have large accumulations of lime. In places, the soil is strongly alkaline or very strongly alkaline. In places, the transitional layer and underlying material are sandy clay loam.

Typically, the Lute soil has a gray, friable, loam surface layer about 4 inches thick. The subsoil is about 19 inches thick. It is dark gray and gray, firm, calcareous loam in the upper part and light gray, friable, calcareous fine sandy loam in the lower part. The underlying material to a depth of 60 inches or more is mottled, light gray, calcareous loamy fine sand in the upper part and light brownish gray sand in the lower part. It is stratified with loamy sand to loam.

Included with these soils in mapping are small areas of Lamo, Gannett, and Ord soils. Lamo and Ord soils are in similar positions on the landscape. Lamo soils have a thicker surface layer. Ord soils contain more sand. Gannett soils are lower on the landscape and are poorly drained or very poorly drained. Included soils make up 10 to 15 percent of this complex.

Permeability in the Lex soil is moderate in the loamy material and very rapid in the underlying coarse sand. Permeability in the Lute soil is slow in the subsoil and rapid in the underlying material. The available water capacity is moderate in both soils. The organic matter content is moderate in the Lex soil and moderately low in the Lute soil. Natural fertility is medium in the Lex soil and low in the Lute soil. Runoff is slow to very slow. Some of the runoff is ponded in microdepressions in the areas of Lute soils. The Lex soil is mildly alkaline or moderately alkaline. The Lute soil is neutral to very strongly alkaline. The Lute soil is high in sodium content. The seasonal high water table ranges from a depth of about 1.5 feet in wet years to 3.0 feet in dry years. The Lex soil has a moderate water intake rate, but the Lute soil takes in water slowly. The Lute soil is sticky when wet and becomes very hard and cloddy when dry. The Lex soil has good tilth and is easy to work. The Lute soil is difficult to work and keep in good tilth.

A large acreage of this soil is used for cropland, and much of it is irrigated. The areas in native grass are grazed or harvested for hay.

Under dryland farming, this complex is poorly suited to corn, sorghum, small grains, alfalfa, and alkali-tolerant grasses. The Lex soil is suited to crops commonly grown in the county, but the Lute soil is intermixed; both soils must be managed together. Crops do not grow well on the Lute soil because moisture and plant nutrients are not readily available in areas affected by the alkali. For

this reason, crop growth is not uniform. The seasonal high water table causes wetness that delays tillage operations and causes the soil to warm up slowly in the spring. Growing legumes and returning crop residue to the soil increases the organic matter content and improves fertility. Large applications of barnyard manure to the Lute soil will increase porosity and improve the water intake rate and fertility.

Under irrigation, this complex is poorly suited to corn, sorghum, alfalfa, small grains, and alkali-tolerant grasses. The soils are suited to gravity or sprinkler methods of irrigation. Some land shaping is needed for gravity irrigation. Water stands on the surface in some of the alkali spots if the area is not graded and smoothed. Deep cuts should be avoided in order to prevent exposing the coarse underlying material. Maintenance of fertility, wetness caused by the high water table, and alkalinity are problems in managing areas of these soils. Generally, tiling is not necessary for irrigation, but wetness is a problem in spring or during periods of above normal rainfall. Fertility needs to be balanced because the alkalinity in the Lute soil makes many nutrients unavailable to plants. Soil fertility can be improved by growing legumes, returning crop residue to the soil, and using barnyard manure. Adding barnyard manure to the Lute soil makes the soil more friable and increases the water intake rate. Additions of chemicals are needed to neutralize the alkali in the Lute soil.

The reclamation of alkali soil is difficult, expensive, and time consuming. Technical help is needed before reclamation is begun, and the area needs to be fully investigated.

The alkali conditions can be improved by adding chemical amendments, leaching the soil, and using practices that build soil structure. Chemical amendments, such as gypsum and sulfur, are expensive. It is sound practice to determine the kind and amount of amendments needed on the basis of chemical soil tests. The common method of leaching is to pond water over the alkali areas. The amount of leaching water that enters the soil determines how much salt is removed from the soil. Leaching is not successful if the water table is too high. The water table needs to be lowered to 4.5 to 5 feet below the surface during the growing season. Where suitable outlets are available, tile drains or open ditches can be used to lower the water table. Applications of manure or other forms of organic matter are needed to help improve the soil structure after chemical treatment and leaching are completed.

This complex is suited to rangeland, either grazing or haying. Overgrazing, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and restricted use during very wet periods help to maintain the native plants in good condition. The Lute soil becomes puddled if it is grazed or if hay is harvested when it is too wet.

The Lex soil is suited and the Lute soil is poorly suited to trees and shrubs planted in windbreaks. Before using these soils for windbreaks, onsite investigation should be made. Only trees and shrubs that are tolerant of alkali and wetness are suited. Competition from undesirable grasses and weeds can be controlled by cultivation and timely use of herbicides. Areas in the row and close to the trees can be rototilled or hoed by hand. In wet years, planting needs to be delayed until the soil is sufficiently dry. Irrigation can provide supplemental moisture during periods of insufficient rainfall.

Before using areas of this complex for engineering uses, onsite investigation is needed. Septic tank absorption fields can be constructed on fill material so that the absorption field can be placed a sufficient distance above the seasonal high water table. Sewage lagoons need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal high water table. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Digging when the soil is not wet is easier and helps to avoid caving and water problems. Dwellings and buildings need to be constructed on raised, well compacted fill material to overcome wetness caused by the high water table and as protection against flooding. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarser grained material for subgrade or base material can be used to ensure better performance. Damage to roads by frost action can be reduced by providing good surface drainage and by the use of a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This complex is in capability units IVs-1 dryland and IIIs-7 irrigated. The Lex soil is in the Subirrigated range site and windbreak suitability group 2S. The Lute soil is in the Saline Subirrigated range site and windbreak suitability group 9S.

LkB—Libory loamy fine sand, 0 to 3 percent slopes. This deep, nearly level to very gently sloping, moderately well drained soil is on stream terraces. Individual areas range from 5 to 500 acres.

Typically, the surface layer is gray, very friable loamy fine sand about 12 inches thick. The subsurface layer is grayish brown, very friable loamy fine sand about 6 inches thick. The next layer is mottled, pale brown, loose fine sand about 12 inches thick. Beneath this is a subsoil layer of light brownish gray, friable silty clay loam about 12 inches thick. The underlying material is light gray silty clay loam to a depth of more than 60 inches. It has light

yellowish brown mottles. In places, the sandy material is less than 20 inches thick. In places, the sandy material is more than 36 inches thick over the loamy material. In places, this soil has sandy clay loam, clay loam, or sandy loam below a depth of 20 inches. In a few places, coarse sand or gravelly coarse sand is below a depth of 40 inches.

Included with this soil in mapping are small areas of Dunday, Elsmere, Ipage, and Valentine soils. Dunday and Ipage soils are in similar positions on the landscape, but they do not have the loamy underlying material. The Elsmere soils are lower on the landscape and are somewhat poorly drained. Valentine soils are higher on the landscape and are excessively drained. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Libory soil is rapid in the upper part and moderate or moderately slow in the lower part. The available water capacity is moderate, and the organic matter content is moderately low. Natural fertility is medium. The Libory soils range from medium acid to neutral in the upper part of the profile and are neutral or mildly alkaline in the lower part. The water intake rate is high. Runoff is slow. In the spring and during wet periods of the year, a water table is perched for a short time above the loamy underlying material. This soil is easily tilled.

A large acreage of this soil is farmed. Some areas are irrigated. The rest is in native grass and is used as rangeland or hayland.

Under dryland farming, this soil is suited to corn, small grains, and alfalfa. Soil blowing is a hazard where the surface is not adequately protected by growing crops or crop residue. Conservation tillage practices, such as discing or chiseling, that keep all or part of the crop residue on the soil surface help to prevent soil blowing and conserve soil moisture. Small grains and first cutting alfalfa are generally dependable crops because they grow and mature in spring when rainfall is highest. Adding barnyard manure increases the organic matter content and fertility.

Under irrigation, this soil is suited to corn, soybeans, sorghum, alfalfa, and introduced grasses. In periods of above normal rainfall, wetness caused by the perched water table is a problem in some places. Soil blowing is a hazard where the surface is not adequately protected by growing crops or crop residue. Conservation tillage practices, such as discing, that leave crop residue on the surface help to prevent soil blowing and conserve soil moisture. Light, frequent applications of irrigation water are necessary. Excessive water leaches fertilizers below the plant roots. Returning crop residue to the soil and using barnyard manure help to increase the organic matter content and improve fertility.

This soil is suited to rangeland, either grazing or haying. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. Only trees or shrubs that are tolerant of slightly sandy, somewhat droughty conditions are suited. Inadequate moisture and severe soil blowing are the main hazards in establishing trees. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the rows. Supplemental water needs to be provided by irrigation during extended dry periods. Undesirable grasses and weeds can be controlled by cultivation or by using appropriate herbicides.

Septic tank absorption fields can be constructed on fill material so that the absorption field is placed a sufficient distance above the perched water table. The material in the upper part of this soil has poor filtering capacity. It readily absorbs effluent from septic tank absorption fields, but it does not adequately filter the effluent. Care should be taken so that the fill material used for the absorption field functions properly and avoids contamination of the underground water table. Sewage lagoons need to be lined or sealed to prevent seepage and need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the water table. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Digging during dry periods reduces wetness problems. Dwellings and buildings need to be constructed on raised, well compacted fill material to overcome wetness caused by the perched water table. Constructing roads on suitable, well compacted fill material and providing adequate side ditches and culverts help to protect roads from wetness.

This Libory soil is in capability units IIIe-6 dryland and IIIe-10 irrigated. It is in the Sandy Lowland range site and windbreak suitability group 5.

LmB—Libory-Whitelake loamy fine sands, 0 to 3 percent slopes. These deep, moderately well drained soils are on stream terraces. The complex is made up of areas of nearly level to very gently sloping Libory soil and nearly level Whitelake soil. Libory soil is slightly higher on the landscape than Whitelake soil. Individual areas of this complex range from 5 to 300 acres. The complex is 40 to 55 percent Libory soil and 20 to 35 percent Whitelake soil. Areas of Whitelake soil are irregular in size and shape and are intermixed with the Libory soil. Most areas of Whitelake soil occur in spots 5 to 100 feet across. The two soils are so intricately mixed that it was not practical to separate them in mapping.

Typically, the Libory soil has a surface layer of dark gray, very friable loamy fine sand about 8 inches thick. The subsurface layer is similar to the surface layer in color and texture and is about 6 inches thick. The next layer is grayish brown, very friable loamy fine sand about

6 inches thick. Below this is a subsoil layer of mottled, very pale brown, friable silt loam about 6 inches thick. The underlying material is mottled, white, calcareous silt loam to a depth of more than 60 inches. In places, the surface layer is fine sandy loam. In places, the sandy material is less than 20 inches thick, and, in places, more than 36 inches thick over the loamy material. In places, the loamy underlying material is sandy clay loam or clay loam.

Typically, the Whitelake soil has a surface layer of dark gray, very friable loamy fine sand about 6 inches thick. The subsurface layer is gray, loose loamy fine sand about 2 inches thick. The subsoil is grayish brown, friable, calcareous fine sandy loam about 10 inches thick. The underlying material is light gray, calcareous fine sandy loam in the upper part and mottled, light gray, calcareous very fine sandy loam in the lower part. It extends to a depth of more than 60 inches. In places, the surface layer is fine sand. In a few places, calcareous siltstone is below a depth of 40 inches.

Included with these soils in mapping are small areas of Dunday, Ipage, Lawet, and Ord soils. Dunday soils are sandy throughout the profile and are higher on the landscape than the Libory soils. Ipage soils are in similar landscape positions as Libory soils, but they do not have the loamy underlying material. Lawet and Ord soils are in similar positions on the landscape as the Lute soils and are somewhat poorly drained. Included soils make up 15 percent of the map unit.

Permeability of the Libory soil is rapid in the upper part of the profile and moderate or moderately slow in the lower part. Permeability of the Whitelake soil is slow in the subsoil and moderate in the underlying material. The available water capacity is moderate in the Libory soil and high in Whitelake soil. Whitelake soil takes in water slowly and releases it slowly to plants. Libory soil has a high water intake rate. The organic matter content is moderately low in both soils. Natural fertility is medium in Libory soil and low in Whitelake soil. Runoff is slow to very slow, and some of it is ponded in microdepressions in areas of Whitelake soils. The Libory soil ranges from medium acid to neutral in the sandy upper part and is neutral or mildly alkaline in the loamy lower part. Whitelake soil ranges from neutral to mildly alkaline in the upper part and from moderately alkaline to very strongly alkaline in the lower part. The Whitelake soil is high in content of sodium and other salts that influence its use and management. The Libory soil has a perched water table at a depth of 1.5 to 3 feet, and Whitelake soil has a perched water table at a depth of 1 to 2 feet.

This complex is mostly in native grass and is used for grazing or hay. The remaining acreage is used for cropland, and some of it is irrigated.

Under dryland farming, this complex is poorly suited to corn, small grains, and sorghum. Alfalfa and alkali-tolerant grasses can be grown. The principal limitations are alkalinity and the hazard of soil blowing. Growth of crops is spotty, but small grains and first cutting alfalfa are usually dependable because they grow and mature in spring when rainfall is usually highest. Plant nutrients and moisture are not readily available in areas of the Whitelake soil, and crop stands are poor (fig. 15). Tillage is difficult in areas of Whitelake soil. The soil puddles easily and becomes hard and cloddy when it dries out. Whitelake soil absorbs moisture slowly and releases it slowly to plants. Libory soil is easy to till. Soil blowing is a hazard on Libory soil if the surface is not protected. Soil blowing can be controlled by using winter cover crops, stubble mulch tillage, or close-growing crops. Returning crop residue to the soil, growing legumes, and using barnyard manure increase organic matter content and improve fertility.

Under irrigation, this complex is poorly suited to corn, sorghum, and small grains. Alfalfa and alkali-tolerant grasses are better suited. Sprinkler irrigation is better suited to this soil than gravity irrigation because it does not require land shaping. Applications of irrigation water need to be light and frequent. Some grading is needed to fill small depressions and improve surface drainage in the areas of Whitelake soil. Crops do not grow as well on the Whitelake soil as they do on the Libory soil. Alkali makes it difficult for crops to take up water and nutrients. Wetness caused by the perched water table can be a problem in places. Soil fertility can be improved by growing legumes, returning crop residue to the soil, and adding barnyard manure to the soil. Soil blowing can be controlled by using a cropping system that keeps the soil covered most of the time with crops, grass, or crop residue. Chemicals are needed to neutralize the alkali in the Whitelake soil.

Reclaiming areas of alkali soils is expensive and time consuming. Technical help is needed before reclamation is begun, and the area needs to be thoroughly investigated.

The alkali conditions can be improved by adding chemical amendments, leaching the soils, and using practices that build soil structure. Chemical amendments, such as gypsum and sulphur, are expensive. It is sound practice to determine the kind and amounts needed on the basis of chemical soil tests. The common method of leaching is to pond water over the alkali area. The amount of leaching water that enters the soil determines how much salt is removed from the soil. Heavy applications of manure or other forms of organic matter are then needed to help improve the soil structure.

This complex is suited to rangeland, either for grazing or haying. This use is effective in controlling soil blowing. Ranchers can usually make allowances in the grazing use to fit the alkali conditions. Overgrazing, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use and timely deferment from grazing or haying help to maintain and improve the range condition.

Figure 15.—Dryland corn in an area of Libory-Whitelake loamy fine sands, 0 to 3 percent slopes. Poor stands and stunted growth is typical in areas of alkali-affected Whitelake soils. Growth of corn is usually good in areas of Libory soils.

Where these soils are used for hayland, mowing needs to be regulated so that the grasses remain vigorous and healthy. A proper mowing sequence should be followed. The meadow should be cut before the dominant grasses reach the boot stage. Mowing should be avoided between boot stage and seed maturity. After frost and during winter, range animals can graze the meadows without damage if areas are properly stocked.

The Libory soil in this complex is suited to trees and shrubs planted in windbreaks. The Whitelake soil is poorly suited. Because of the intermixed composition of the soils, this complex should be treated as one unit unless an onsite investigation is made to select a site. Soil blowing can be controlled on Libory soil by maintaining strips of sod or cover crops between the rows. The effect of alkali can be minimized by using salt-tolerant species. In areas of Whitelake soil, establishment of seedlings can be a problem during wet years. Weeds and grasses can be controlled in the tree rows by using the appropriate herbicide, or the areas can be hoed by hand.

Septic tank absorption fields can be constructed on fill material so that the absorption field can be placed a sufficient distance above the perched water table. Care should be taken to be sure that the proper fill material is used so that the absorption field works properly and does not contaminate nearby water supplies. The sandy material in the upper part of the Libory soil readily absorbs effluent from absorption fields, but it does not adequately filter the effluent. The moderate permeability of the Whitelake soil is a limitation for septic tank absorption fields, but this can generally be overcome by increasing the size of the absorption field. Sewage lagoons need to be lined or sealed to prevent seepage and need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the perched water table. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Digging during dry periods helps to

avoid wetness problems. Dwellings and buildings need to be constructed on raised, well compacted fill material to overcome wetness caused by the perched water table. Damage to roads by frost action can be reduced by providing good surface drainage and by the use of a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. Constructing roads on suitable, well compacted fill material and providing adequate side ditches and culverts help to protect roads from wetness.

This complex is in capability units IVs-1 dryland and IVs-10 irrigated. The Libory soil is in the Sandy Lowland range site and windbreak suitability group 5. The Whitelake soil is in the Saline Lowland range site and windbreak suitability group 9S.

LnC—Loretto loam, 2 to 6 percent slopes. This deep, gently sloping, well drained soil is on upland side slopes. Individual areas range from 10 to 300 acres.

Typically, the surface layer is grayish brown, very friable loam about 7 inches thick. The subsurface layer is dark grayish brown, very friable loam about 4 inches thick. The subsoil is about 41 inches thick. It is dark brown, very friable loam in the upper part; brown, friable silty clay loam in the middle part; and yellowish brown, friable silty clay loam in the lower part. The underlying material is light yellowish brown clay loam to a depth of 60 inches or more. In places, the surface layer is fine sandy loam. In eroded places, the surface layer is brown or yellowish brown silty clay loam or clay loam.

Included with this soil in mapping are small areas of Anselmo, Jansen, Nora, and O'Neill soils. Anselmo soils are in similar landscape positions and contain more sand. Jansen, Nora, and O'Neill soils are normally higher on the landscape. Jansen and O'Neill soils are underlain with coarse sand or gravelly coarse sand at a depth of 20 to 40 inches. Nora soils contain less sand. Included soils make up 5 to 10 percent of this map unit.

Permeability of this Loretto soil is moderate. The available water capacity is high. The organic matter content is moderate, and natural fertility is medium. The soil ranges from medium acid or slightly acid in the surface layer to moderately alkaline in the underlying material. Runoff is medium.

Most of the acreage of this soil is used as dryland cropland. The remaining acreage is in native grass and is used as rangeland.

Under dryland farming, this soil is suited to corn, sorghum, alfalfa, soybeans, small grains, and introduced grasses. Small grains and the first cutting of alfalfa are generally more dependable because they grow and mature in spring when rainfall is highest. Sorghum is better suited than corn. Water erosion is a hazard. Terraces and contour stripcropping reduce runoff and help to control erosion. Keeping the soil covered with crops or crop residue reduces erosion and conserves soil moisture. Adding barnyard manure increases the organic matter content and improves fertility.

Under irrigation, this soil is suited to corn, sorghum, alfalfa, soybeans, and introduced grasses. Sprinkler irrigation is suited to this soil. Slopes need to be reduced by bench leveling or contour bench leveling before this soil can be gravity irrigated. Water erosion is a hazard. Wheel track erosion can be a problem if center-pivot irrigation systems are used. Adjusting the rate of water application to the water intake rate of the soil helps to reduce erosion in the wheel tracks. Terraces, contour farming, and stripcropping reduce runoff and help to control erosion. Stubble mulch tillage practices that keep crop residue on the surface reduce runoff and help to conserve soil moisture. Returning crop residue to the soil improves the organic matter content and increases the water intake rate.

This soil is suited to rangeland. This use is effective in controlling water erosion. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Overgrazing can result in severe soil losses by water erosion. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. Drought, water erosion, and competition from weeds and undesirable grasses are the main hazards. Irrigation can provide supplemental moisture during periods of insufficient rainfall. Trees can be planted on the contour in combination with terraces to allow cultivation between the rows to conserve moisture and control undesirable grasses and weeds. Careful use of appropriate herbicides or hand cultivation can control weeds in the rows.

This soil is generally suited to use as septic tank absorption fields, sites for dwellings, and shallow excavations. Sewage lagoons need to be lined or sealed to prevent seepage. Small commercial buildings need to be designed to accommodate the slope, or the soil can be graded to an acceptable gradient. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarser grained material for subgrade or base material can be used to ensure better performance.

This Loretto soil is in capability units IIIe-1 dryland and IIIe-4 irrigated. It is in the Silty range site and windbreak suitability group 3.

Lp—Loup fine sandy loam, 0 to 2 percent slopes. This soil is deep, nearly level, and poorly drained. It is on valley floors in sandhill areas and on bottom lands along drainageways. This soil is rarely flooded. Individual areas range from 5 to more than 1,000 acres.

Typically, the surface layer is calcareous, very dark gray, very friable fine sandy loam about 6 inches thick.

The subsurface layer is dark gray, very friable fine sandy loam about 4 inches thick. The transitional layer is gray, loose fine sand about 4 inches thick. It has dark brown mottles. The mottled underlying material to a depth of about 60 inches is light gray and grayish brown fine sand in the upper part and dark gray fine sandy loam in the lower part. In places, a thin layer of silty clay loam is in the lower part of the surface layer. In places, the surface layer is less than 7 inches thick. In places, the transitional layer is sandy loam to silt loam. A thin layer of light colored fine sand is on the surface in some areas near the sandhills. In a few places, the underlying material is finely stratified with sandy and loamy textures. Water stands on the surface in low areas and drainageways for a few days in the spring and during wet periods.

Included with this soil in mapping are small areas of Elsmere, Marlake, and Ord soils. Elsmere and Ord soils are higher on the landscape and have a lower seasonal water table. Marlake soils are lower on the landscape and have a higher seasonal water table. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Loup soil is rapid, and the available water capacity is low. Natural fertility is medium, and the organic matter content is high. The soil is neutral to moderately alkaline. Runoff is very slow. The seasonal high water table ranges from at the surface in wet years to about 1.5 feet in dry years. It normally recedes to a depth of 2 to 3 feet by late in summer.

Areas of this soil are in native grass and are used as range or hayland.

The soil is normally too wet for use as cropland.

This soil is suited to rangeland, either for grazing or haying. Overgrazing by livestock reduces the protective cover and causes the native plants to deteriorate. If the soil is wet, overgrazing can cause surface compaction and small mounds, making it difficult to graze or harvest for hay. Proper grazing use, timely deferment from grazing, and restricted use during very wet periods help to maintain the native plants in good condition.

Where this soil is used as hayland, mowing needs to be regulated so that the grasses remain vigorous. In order to allow for carbohydrate storage in the plants in meadows, mowing should be avoided between boot stage and seed maturity. Large areas can be divided into three parts and mowed in rotation. One third should be mowed two weeks before the plants reach the boot stage, one third at boot stage, and one third early in the flowering period. The areas should be rotated in successive years. If a rancher has plenty of hay, the entire area can be left idle one year in three, particularly if the rotation mowing plan is not followed. Hay production can be increased by proper fertilization with nitrogen and phosphate. After frost and during winter, range animals can usually graze meadows without damage if the areas are properly stocked. Range animals should be removed before frost leaves the soil and the water table reaches a high level.

This soil is poorly suited to trees and shrubs planted in windbreaks. Only trees and shrubs that are tolerant of a very high water table are suited to this soil. Establishment of trees can be a problem in wet years and may require special methods of planting in order that seedlings do not drown. Planting should be delayed until the water table recedes and the soil dries out so it can be tilled. Weeds and undesirable grasses can be controlled by cultivation when the water table is lowest.

This soil is not suited to septic tank absorption fields and dwellings because of wetness. A suitable alternate site is needed. Sewage lagoons need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal high water table. Sewage lagoons need to be lined or sealed to prevent seepage. Small commercial buildings can be constructed on well compacted fill material to overcome wetness caused by the high water table and as protection against flooding. Constructing roads on suitable, well compacted fill material and providing adequate side ditches and culverts help to protect roads from wetness.

This Loup soil is in capability unit Vw-7 dryland. It is in the Wet Subirrigated range site and windbreak suitability group 2D.

Lr—Loup fine sandy loam, wet, 0 to 2 percent slopes. This deep, nearly level, very poorly drained soil is on valley floors in sandhill areas and on bottom lands along drainageways. This soil is rarely flooded, but it is occasionally ponded by water from a very high water table. Individual areas range from 5 to 250 acres.

Typically, the surface layer is dark gray, very friable fine sandy loam about 6 inches thick. The subsurface layer is similar to the surface layer in color and texture and is about 6 inches thick. The underlying material is white, mottled fine sand to a depth of more than 60 inches. In places, the surface layer is loam or sandy clay loam. A thin layer of silty clay loam is in the lower part of the surface layer in some pedons. In a few places, the surface layer is less than 7 inches thick. In places, the transitional layer is sandy loam to silt loam. A thin layer of light colored fine sand is on the surface in some areas near the sandhills. Coarse sand is below a depth of 20 inches in some places.

Included with this soil in mapping are small areas of Elsmere, Marlake, and Ord soils. Elsmere and Ord soils are on higher positions and are somewhat poorly drained. Marlake soils are lower on the landscape and have a higher seasonal water table. Alkali is common along the outer edges of areas of this soil. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Loup soil is rapid, and the available water capacity is low. Natural fertility is medium, and the organic matter content is high. The soil is neutral to moderately alkaline. Runoff is very slow.

The seasonal high water table ranges from about 0.5 foot above the surface in wet years to about 1.0 foot below the surface in dry years. Water can stand on the surface of this soil for a week or more during wet periods. The water table normally recedes to a depth of 1 foot to 2 feet by late summer.

Areas of this soil are in native grass and are used as range or hayland.

The soil is not suited to cropland because it is too wet.

This soil is suited to rangeland, either for grazing or hayland. Overgrazing reduces the protective cover and causes deterioration of the native plants. In addition, when the soil is wet, overgrazing can cause surface compaction and mounds, making it difficult to graze or cut for hay. Proper grazing use, timely deferment from grazing, and restricted use during very wet periods help to maintain the native plants in good condition.

Where this soil is used as hayland, mowing needs to be regulated so that the grasses remain vigorous. Some hay meadows can be improved by installing V-ditches to hasten surface drainage and by seeding reed canarygrass into the existing grasses. In some years, forage cannot be harvested because of wetness. A proper mowing sequence should be followed. The meadow should be cut before the dominant grasses reach the boot stage. Mowing should be avoided between boot stage and seed maturity. After frost and during winter, animals can graze the meadows without damage if the areas are properly stocked. Range animals should be removed before frost leaves the soil and the water table reaches a high level.

This soil is unsuited to trees and shrubs planted in windbreaks because of wetness. Some areas can be used for recreational, wildlife, or forestation plantings of tolerant trees and shrubs if they are planted by hand or other special practices are used.

This soil is not suited to septic tank absorption fields and dwellings because of wetness and ponding. A suitable alternate site is needed. Sewage lagoons need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal high water table and ponding level. Sewage lagoons need to be lined or sealed to prevent seepage and diked as protection from ponding. Small commercial buildings can be constructed on fill material to overcome ponding caused by the high water table and as protection against flooding. Constructing roads on suitable, well compacted fill material above the ponding level and providing adequate side ditches and culverts help to protect roads from damage by ponding and wetness from the seasonal high water table.

This Loup soil is in capability unit Vw-7 dryland. It is in the Wetland range site and windbreak suitability group 10.

Ls—Loup-Inavale complex, channeled. These soils are on bottom lands dissected by stream channels that meander back and forth across the flood plain. Slopes range from 0 to 2 percent. This complex consists of deep, poorly drained Loup soil and deep, somewhat excessively drained Inavale soil. The areas of Loup soil are subject to frequent flooding, but floodwaters remain on the surface for only a short period of time. The areas of Inavale soil are on higher bottom land positions and are rarely flooded. Individual areas of this complex range from 20 to 1,000 acres. The complex is 35 to 55 percent Loup soil and 20 to 40 percent Inavale soil. The soils are so intricately mixed it was not practical to separate them in mapping.

Typically, the Loup soil has a surface layer of dark gray, very friable, calcareous fine sandy loam about 10 inches thick. The transitional layer is gray, very friable loamy fine sand about 4 inches thick. The underlying material is light brownish gray and light gray fine sand to a depth of more than 60 inches. It has reddish brown mottles. Dark buried layers are common. In places, the surface layer is less than 7 inches thick. In places, a thin layer of sand is deposited on the surface. In places, the underlying material contains strata of finer and coarser material. In a few places, gravelly coarse sand is at a depth of 20 to 40 inches.

Typically, the Inavale soil has a surface layer of dark grayish brown, very friable loamy fine sand about 5 inches thick. The transitional layer is grayish brown, loose fine sand about 4 inches thick. The underlying material is light gray fine sand stratified with lighter and darker material to a depth of more than 60 inches. Mottles are below a depth of 42 inches. In places, the surface layer is sand.

Included with these soils in mapping are areas of Boel, Elsmere, and Marlake soils. The somewhat poorly drained Boel and Elsmere soils are higher on the landscape than the Loup soil and lower on the landscape than the Inavale soil. The very poorly drained Marlake soil is lower on the landscape and has a higher seasonal water table. Included soils make up 10 to 15 percent of the map unit.

Permeability in the Loup and Inavale soils is rapid, and the available water capacity is low. The Loup soil is high in organic matter content and medium in natural fertility. The Inavale soil is low in organic matter content and natural fertility. The Loup soil is neutral to moderately alkaline, and the Inavale soil is slightly acid or neutral. Runoff is very slow. The seasonal high water table in the Loup soil ranges from at the surface in wet years to a depth of about 1.5 feet in dry years. It recedes to a depth of 5 or 6 feet in some areas during extended dry periods. The water table in the Inavale soil is normally below a depth of 6 feet. The depth to the water table in these areas is directly affected by the depth of water flowing in the nearby stream.

All of the acreage of this complex is in native grass. Most areas are used as rangeland, but a few small areas are used as hayland.

This complex is not suited to cropland because the Loup soil is too wet for cultivation. Most areas are managed with adjoining areas of range or hayland.

This complex is suited to rangeland, either for grazing or haying. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and restricted use during wet periods help to maintain the native plants in good condition. Boggy conditions develop in some areas if they are grazed when they are too wet.

This complex is unsuited to trees and shrubs planted in windbreaks because of wetness and flooding. Some areas can be used for recreational, wildlife, and forestation plantings of tolerant trees and shrubs if they are planted by hand or other special approved practices are used.

These soils are generally not suited to use as septic tank absorption fields, sewage lagoons, and building sites because of flooding. A suitable alternate site is needed. Constructing roads on suitable, well compacted fill material above the flooding level and providing adequate side ditches and culverts help to protect roads from damage by flooding and wetness.

This complex is in capability unit VIw-7 dryland and windbreak suitability group 10. The Loup soil is in the Wet Subirrigated range site, and the Inavale soil is in the Sandy Lowland range site.

LxC—Lynch silty clay, 2 to 6 percent slopes. This moderately deep, gently sloping, well drained soil is on ridgetops and lower side slopes of uplands. It formed in material weathered from light colored shales, which are typically lower on the landscape than the adjoining dark shales. Individual areas range from 5 to 60 acres.

Typically, the surface layer is grayish brown, calcareous, friable silty clay about 7 inches thick. The subsoil is calcareous, firm silty clay about 16 inches thick. It is light yellowish brown in the upper part, light brownish gray in the middle part, and pale yellow in the lower part. The underlying material to a depth of about 28 inches is light gray, calcareous silty clay. Pale yellow and white bedded shale is at a depth of about 28 inches. In places, the bedded shale is below a depth of 40 inches. In places, the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Bristow and Labu soils. Bristow soils are in similar positions on the landscape as the Lynch soil and have clay shale at a depth of 5 to 20 inches. Labu soils formed in dark shales and are normally higher on the landscape. In places, a thin layer of sandy material is deposited on the surface. Included soils make up 5 to 15 percent of this map unit.

Permeability of this Lynch soil is slow. The available water capacity and natural fertility are low. The organic matter content is moderately low. This soil is moderately alkaline or strongly alkaline above the bedded shale. This soil is low in available phosphorus; the high lime content makes the phosphates unavailable in plants. Good tilth is difficult to maintain unless the soil is tilled at the proper moisture level. This soil compacts readily if worked when wet. The clayey texture of this soil causes it to release moisture slowly to plants, making the soil somewhat droughty. Runoff is medium.

Most of the acreage of this soil is used as cropland. The remaining areas are in native grass and are used as rangeland.

Under dryland farming, this soil is suited to small grains, sorghum, corn, alfalfa, and introduced grasses. Small grains and first cutting alfalfa are best suited because they mature early in the spring when rainfall is highest. Sorghum is better suited than corn. Phosphate fertilizer is needed for alfalfa production. An initial application at the time of seeding with top dressing every other year is a common method of applying phosphate to alfalfa. Because of its clayey texture, this soil absorbs water slowly. This results in runoff, which can cause erosion. Keeping a good cover of crop residue on the surface helps to protect the soil from water erosion. A cropping system that returns a large amount of crop residue to the soil and the addition of barnyard manure help to improve the organic matter content and natural fertility. Areas that have long, continuous slopes should be terraced and farmed on the contour. A grass cover in natural drainageways helps to control erosion.

Under irrigation, this soil is unsuited to cropland because of the clayey texture and very low intake rate.

The use of this soil for rangeland is effective in controlling water erosion. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants, resulting in severe water erosion. Proper grazing use, timely deferments, and a planned grazing system help to maintain or improve the range condition. Restricted use during wet periods helps to prevent surface compaction and keeps the grasses in good condition.

This soil is poorly suited to trees and shrubs planted in windbreaks. Trees can be planted on the contour to save moisture and prevent runoff and erosion. The soil needs to be prepared when it is moist but not wet. Irrigation can provide supplemental moisture for the trees during periods of low rainfall. Undesirable weeds and grasses can be controlled by cultivation between the rows with conventional equipment and with appropriate herbicides in the tree row.

Septic tank absorption fields are not suited to this soil because of slow permeability and depth to bedrock. A suitable alternate site is needed. Sewage lagoons can be constructed on areas of this soil if, after excavation, the bottom of the lagoon is sealed to prevent seepage. Digging is best done when the soil is moist but not wet. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the

shrinking and swelling of the soil. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to ensure better performance. Mixing the base material for roads and streets with additives, such as hydrated lime, helps to prevent shrinking and swelling.

This Lynch soil is in capability unit IIIe-4 dryland. It is in the Limy Upland range site and windbreak suitability group 4C.

LxD—Lynch silty clay, 6 to 11 percent slopes. This soil is moderately deep over light colored shales. It is strongly sloping, well drained, and on ridgetops and side slopes of the uplands. Individual areas range from 5 to 80 acres.

Typically, the surface layer is calcareous, dark grayish brown, friable silty clay about 4 inches thick. The subsurface layer is calcareous, grayish brown, firm silty clay about 3 inches thick. The subsoil is light yellowish brown, calcareous, firm silty clay about 14 inches thick. The underlying material, about 4 inches thick, is light gray, calcareous silty clay. White bedded shale is at a depth of about 25 inches. In places, the surface layer is silty clay loam. In places, the bedded shale is below a depth of 40 inches.

Included with this soil in mapping are small areas of Bristow and Labu soils. Bristow soils are on ridgetops and have the bedded shale at a depth of 5 to 20 inches. Labu soils are in similar positions and formed in the dark shale. In places, sandy material is deposited on the surface. Included soils make up 5 to 15 percent of this map unit.

Permeability of this Lynch soil is slow. The available water capacity and natural fertility are low. The organic matter content is moderately low. The soil is moderately alkaline or strongly alkaline above the bedded shale. This soil is low in available phosphorus. Good tilth is difficult to maintain unless tillage is done at the proper moisture content. The soil becomes compacted if worked or trampled when wet. The clayey texture causes the soil to release moisture slowly to plants and makes the soil somewhat droughty. Runoff is rapid.

Most of the acreage of this soil is in native grass and is used as rangeland. The rest of the acreage is used as cropland.

Under dryland farming, this soil is poorly suited to cultivated crops. The crops most often grown are small grains, sorghum, and alfalfa. Legumes require phosphate fertilizer. An initial application of phosphate at seeding time and as a top dressing every other year has been successful. A cropping system that consists mainly of close-growing crops, such as small grains, legumes, and legume-grass mixtures, are best suited. Legumes and grasses can be grown about half the time, and close-sown crops can be grown the rest of the time. If row crops are included in the cropping sequence, terracing, contour farming, and crop residue management are needed to control erosion and conserve moisture. Grassed waterways may be needed to carry away runoff water without risk of severe erosion.

Under irrigation, this soil is unsuited to cropland because of clayey texture, erosive slopes, and very low intake rate. This soil is suited to rangeland, and its use for range is effective in controlling water erosion. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. It also causes severe soil losses by water erosion. Proper use, timely deferment, and a planned grazing system help to maintain or improve the range condition. Restricted use during wet periods help to prevent surface compaction and keep the grasses in good condition.

This soil is poorly suited to trees and shrubs planted in windbreaks. Water erosion is a serious hazard on these strongly sloping areas. Trees can be planted on the contour to save moisture and help prevent excessive runoff. Irrigation can provide supplemental water during periods of low rainfall. The soil needs to be worked when moist but not wet. Competition from undesirable grasses and weeds can be controlled between the tree rows by cultivating with conventional equipment and by using appropriate herbicides in the tree rows.

Septic tank absorption fields are not suited to this soil because of the slow permeability and depth to bedrock. A suitable alternate site is needed. Sewage lagoons can be constructed on areas of this soil if, after excavation, the bottom of the lagoon is sealed to prevent seepage. Grading is required to modify the slope and shape the lagoon. Digging should be done when the soil is moist but not wet. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Small commercial buildings need to be properly designed to accommodate the slope, or the soil can be graded to an acceptable gradient. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarser grained material for subgrade or base material can be used to ensure better performance. The base material for roads and streets can be mixed with additives, such as hydrated lime, to help prevent shrinking and swelling.

This Lynch soil is in capability unit IVe-4 dryland. It is in the Limy Upland range site and windbreak suitability group 4C.

Ma—Marlake fine sandy loam, 0 to 2 percent slopes. This deep, nearly level, very poorly drained soil is mostly in depressions or basins on valley floors and in low areas bordering lakes and streams. In a few places, it is on bottom lands along major drainageways that are occasionally flooded. The soil is frequently ponded by

water from a very high water table. Individual areas range from 5 to 100 acres.

Typically, the surface layer is dark gray, very friable, calcareous fine sandy loam about 7 inches thick. The transitional layer is grayish brown, very friable loamy fine sand that is finely stratified with dark gray fine sandy loam and light gray sand. The transitional layer is about 9 inches thick and has yellowish brown mottles. The underlying material is light gray fine sand stratified with thin strata of loamy sand to a depth of more than 60 inches. It has yellowish brown mottles in the upper part. In places, loamy material is below a depth of 40 inches.

Included with this soil in mapping are small areas of Loup and Tryon soils. These soils have a lower seasonal water table and are slightly higher on the landscape. Also included are small lakes in low areas. In places, the outer edges of areas of this soil are severely affected with alkali. Included soils make up 5 to 10 percent of the map unit.

Permeability of this Marlake soil is rapid, and the available water capacity is low. Natural fertility is medium, and the organic matter content is high. The soil is neutral to moderately alkaline. Runoff is generally ponded in areas of this soil. The seasonal high water table ranges from as much as 2 feet above the surface in wet years to about 1 foot below the surface in dry years. Water stands on the surface of this soil for long periods during most years. During extended dry periods, the water table normally recedes below the surface.

Areas of this soil are used mostly as wildlife habitat. In drier years, some areas in meadows are mowed for mulching material or to clear off the dead residue.

Areas of this soil are too wet for cultivated cropland, hayland, or range. The vegetation is coarse and nonpalatable for livestock. Vegetation consists mainly of cattails, rushes, arrowheads, willows, and other water-tolerant plants. In some places, V-ditches can be installed to hasten and improve surface drainage. Grasses, such as prairie cordgrass and reed canarygrass, can then be established in the areas. Excessive wetness prevents mowing across these areas, except in extremely dry years.

This soil is unsuited to trees and shrubs planted in windbreaks because of wetness. A few marginal areas can be used for recreational, wildlife, and forestation plantings of tolerant trees or shrubs if they are planted by hand or other approved special practices are used.

This soil is generally not suited to use as septic tank absorption fields, sewage lagoons, and building sites because of ponding from the seasonal high water table. A suitable alternate site is needed. Constructing roads on suitable, well compacted fill material above the ponding level and providing adequate side ditches and culverts help to protect roads from damage by ponding from the seasonal high water table.

This Marlake soil is in capability unit VIIIw-7 and windbreak suitability group 10. It is not assigned to a range site.

MeB—Meadin sandy loam, 0 to 3 percent slopes. This nearly level to very gently sloping, excessively drained soil is on uplands and stream terraces. It is shallow over gravelly coarse sand. Individual areas range from 5 to 400 acres.

Typically, the surface layer is dark gray, very friable sandy loam about 12 inches thick. The transitional layer is dark grayish brown, very friable loamy sand about 6 inches thick. The underlying material is light yellowish brown and very pale brown, gravelly coarse sand to a depth of more than 60 inches. In some areas, reddish brown iron stains are at a depth of 40 to 60 inches. The surface texture is loam, fine sandy loam, or loamy sand in some areas. A clayey layer 3 to 6 inches thick is in some profiles above the gravelly coarse sand. The gravelly coarse sand is at the surface in a few places.

Included with this soil in mapping are small areas of Jansen, O'Neill, Pivot, and Simeon soils. O'Neill, Jansen, and Pivot soils are in similar positions and are thicker over the gravelly coarse sand. Simeon soils are on slightly higher positions on the landscape and have sand underlying material. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Meadin soil is rapid in the upper part and very rapid in the lower part. The available water capacity and natural fertility are low. The organic matter content is moderately low. The soil is strongly acid to neutral. This soil is easily tilled throughout a wide range of moisture content. The water intake rate is high. Runoff is very slow.

A large acreage of this soil is irrigated. The remaining areas are in native grass and are used as rangeland.

This soil is too droughty for dryland cultivation.

Under irrigation, this soil is poorly suited to corn, alfalfa, soybeans, and sorghum. Small grains and introduced grasses are better suited. This soil is best suited to a sprinkler irrigation system. Because of the high intake rate and rapid permeability of the soil, leaching of nutrients below the root zone is a problem if this soil is overirrigated. Water needs to be applied lightly and frequently to avoid leaching. The low available water capacity makes timely irrigations a critical management practice. Slight delays in irrigation water applications can result in partial or complete crop losses on this soil. Conservation tillage practices, such as discing and stubble mulch tillage, keep crop residue at the surface to help control soil blowing and conserve available moisture. Returning crop residue to the soil and using barnyard manure helps to maintain fertility and increase the organic matter content.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock reduces the protective cover and causes deterioration of the

native plants. Proper grazing use, timely deferment, and a planned grazing system help to maintain or improve the range condition.

This soil is unsuited to trees and shrubs planted in windbreaks because of the shallow root zone and low available water capacity. Some areas can be used for recreational, wildlife, and forestation plantings of tolerant trees and shrubs if they are planted by hand or other approved special practices are used.

This soil is generally suited to use as sites for dwellings, small commercial buildings, and local roads and streets. Where this soil is used for septic tank absorption fields, care should be taken so that pollution by seepage does not contaminate nearby water supplies. This soil readily absorbs effluent from septic tank absorption fields, but it does not adequately filter the effluent. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

This Meadin soil is in capability units VIs-4 dryland and IVs-14 irrigated. It is in the Shallow to Gravel range site and windbreak suitability group 10.

MeF—Meadin sandy loam, 3 to 30 percent slopes. This gently sloping to steep, excessively drained soil is on uplands. It is shallow over gravelly coarse sand. It occurs on convex side slopes and ridgetops. Individual areas are irregular in shape and range from 5 to 750 acres.

Typically, the surface layer is dark grayish brown, very friable sandy loam about 8 inches thick. The transitional layer is brown, very friable sandy loam about 4 inches thick. The underlying material is gravelly coarse sand to a depth of more than 60 inches. The upper part is brown, and the lower part is very pale brown. The surface layer in places is loam, fine sandy loam, or loamy sand. In places, the gravelly coarse sand is at the surface.

Included with this soil in mapping are small areas of Brunswick, Inavale, Jansen, O'Neill, Pivot, and Simeon soils. Brunswick, Jansen, O'Neill, Pivot, and Simeon soils are in similar positions on the landscape. Brunswick soils have sandstone at a depth of 20 to 40 inches. Jansen, O'Neill, and Pivot soils are thicker over the gravelly coarse sand. Inavale soils are along the drainageways and contain less gravel. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Meadin soil is rapid in the upper part and very rapid in the lower part. The available water capacity and natural fertility are low. The organic matter content is moderately low. The soil ranges from strongly acid to neutral. Runoff is slow to rapid, depending on the slope gradient.

Nearly all of the acreage of this soil is in native grass.

This soil is unsuited to cultivated crops because of the steepness of slopes, low available water capacity, the shallow root zone, and the hazards of erosion. The soil is extremely droughty.

This soil is suited to rangeland. This use is effective in controlling soil blowing and water erosion. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve the range condition.

Windbreaks are unsuited to this soil because of the shallow root zone and the low available water capacity. The choice of trees is limited. Some areas can be used for recreational, wildlife, and forestation plantings if tolerant trees and shrubs are planted by hand or other approved special practices are used.

Where this soil is used for septic tank absorption fields, care should be taken so that pollution by seepage does not contaminate nearby water supplies. The soil readily absorbs effluent from septic tank absorption fields, but it does not adequately filter the effluent. On slopes of 8 to 15 percent, land shaping and installing the septic tank absorption field on the contour is generally necessary for its proper operation. On slopes of more than 15 percent, this soil is generally not suitable for sanitary facilities. A suitable alternate site is needed. Sewage lagoons need to be lined or sealed to prevent seepage. On slopes of more than 7 percent, grading is required to modify the slope and shape the lagoon. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Steep slopes increase the difficulty of digging. This soil is generally suited to use for dwellings, small commercial buildings, and local roads and streets on slopes of less than 8 percent. On slopes of more than 8 percent, dwellings and small commercial buildings need to be properly designed to accommodate the slope, or the soil can be graded to an acceptable gradient. Cuts and fills are generally needed to provide a suitable grade for roads and streets.

This Meadin soil is in capability unit VIs-4 dryland. It is in the Shallow to Gravel range site and windbreak suitability group 10.

MfB—Meadin loam, 0 to 3 percent slopes. This nearly level to very gently sloping, excessively drained soil is on uplands and stream terraces. It is shallow over gravelly coarse sand. Individual areas range from 5 to 1,000 acres.

Typically, the surface layer is dark grayish brown, friable loam about 7 inches thick. The transitional layer is brown, very friable sandy loam about 9 inches thick. The underlying material is loose, gravelly coarse sand to a depth of more than 60 inches. It is light yellowish brown in the upper part and very pale brown in the lower part. In places, the subsoil is loam or clay loam. Reddish brown and yellowish brown iron stains are common in the underlying material.

Included with this soil in mapping are small areas of Jansen, O'Neill, and Pivot soils. Jansen, O'Neill, and Pivot soils are higher on the landscape and are thicker over the gravelly coarse sand. Included soils make up 10 to 20 percent of this map unit.

Permeability of this Meadin soil is rapid in the upper part and very rapid in the lower part. The organic matter content is moderately low. The available water capacity and natural fertility are low. The soil ranges from strongly acid to neutral. The water intake rate is moderately high. Runoff is very slow. This soil is easily worked.

A large acreage of this soil is in irrigated cropland. The remaining areas are in native grass.

Under dryland farming, this soil is unsuited to cropland because of droughtiness.

Under irrigation, this soil is poorly suited to corn, soybeans, alfalfa, and introduced grasses. Sprinkler irrigation is the method best suited to this soil. Because of the moderately high intake rate and rapid permeability, leaching of nutrients below the root zone is a problem if this soil is irrigated. Water needs to be applied lightly and frequently to avoid leaching. The low available water capacity makes timely irrigation a critical management practice on this soil. Stubble mulch tillage helps to control soil blowing and conserve moisture by keeping crop residue on the surface. Returning crop residue to the soil and using barnyard manure help to maintain or improve fertility and organic matter content.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve the range condition.

This soil is unsuited to trees and shrubs planted in windbreaks because of the shallow root zone and low available water capacity. The choice of trees is limited. Some areas can be used for recreational, wildlife, and forestation plantings of tolerant trees and shrubs if they are planted by hand or other approved special practices are used.

This soil is generally suited to use as sites for dwellings, small commercial buildings, and local roads and streets. Where this soil is used for septic tank absorption fields, care should be taken so that pollution by seepage does not contaminate nearby water supplies. The soil readily absorbs effluent from absorption fields, but it does not adequately filter it. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

This Meadin soil is in capability units VIs-4 dryland and IVs-13 irrigated. It is in the Sandy range site and windbreak suitability group 10.

Nb—Nimbro silt loam, 0 to 2 percent slopes. This deep, nearly level, well drained soil is on low stream terraces. Individual areas range from 5 to 300 acres.

Typically, the surface layer is dark grayish brown, very friable, calcareous silt loam about 7 inches thick. The subsurface layer is dark gray, very friable, calcareous silt loam about 8 inches thick. The mottled, calcareous underlying material extends to a depth of more than 60 inches. It is gray silt loam in the upper part, light brownish gray loam in the middle part, and light gray loamy fine sand and stratified silt loam in the lower part. In places, the surface layer is fine sandy loam. In places, gravelly coarse sand is below a depth of 30 inches.

Included with this soil in mapping are small areas of Cass, Lex, and Lute soils. Cass soils are in similar positions and contain more sand. Lex and Lute soils are lower on the landscape and are somewhat poorly drained. Lute soils are high in sodium content. Included soils make up 5 to 15 percent of this map unit.

Permeability of this Nimbro soil is moderate, and the available water capacity is high. The organic matter content is moderate, and natural fertility is medium. The water intake rate is moderate. The soil is mildly alkaline or moderately alkaline. Runoff is slow. This soil is easy to work and keep in good tilth.

Most of the acreage of this soil is used as cropland. Some of it is irrigated. The remaining acreage is in native grass and is used as rangeland.

Under dryland farming, this soil is suited to corn, sorghum, small grains, soybeans, alfalfa, and introduced grasses. Insufficient precipitation is the major limitation. Stubble mulch tillage leaves crop residue at the soil surface, which helps to conserve soil moisture and reduce soil blowing. Returning crop residue to the soil and adding barnyard manure increase the organic matter content and improve fertility.

Under irrigation, this soil is suited to corn, sorghum, soybeans, alfalfa, and introduced grasses. Sprinkler and gravity irrigation systems are suited to this soil. Some land grading is usually needed for gravity irrigation. Keeping crop residue at the surface and adding barnyard manure increases the intake rate and conserves soil moisture.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system maintain or improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. Irrigation can provide supplemental moisture during periods of low rainfall. Competition for moisture from weeds and grasses can be controlled by cultivating between the rows with conventional equipment. Areas in the row can be tilled by hand, or the appropriate herbicides can be used.

This soil is generally suited to use for septic tank absorption fields and shallow excavations. Sewage lagoons need to be lined or sealed to prevent seepage. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarser grained material for subgrade or base material can be used to ensure better performance.

This Nimbro soil is in capability units IIc-1 dryland and I-6 irrigated. It is in the Silty Lowland range site and windbreak suitability group 3.

No—Nora silt loam, 0 to 2 percent slopes. This deep, nearly level, well drained soil is on uplands. Individual areas range from 5 to 80 acres.

Typically, the surface layer is dark grayish brown, very friable silt loam about 8 inches thick. The subsoil, about 21 inches thick, is brown, very friable silt loam in the upper part; pale brown, very friable silt loam in the middle part; and light yellowish brown, calcareous silt loam in the lower part. The underlying material is a pale yellow, calcareous silt loam to a depth of 60 inches. In places, the surface layer is fine sandy loam or loam and the subsoil is loam. In places, the underlying material is sand, sandy loam, or loam. In places, lime is below a depth of 30 inches. In places, siltstone is at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of Boelus and Trent soils. Boelus soils are on higher parts of the landscape, and they are sandy in the upper part. Trent soils are in swales and are dark to a depth of more than 20 inches. Included soils make up 10 to 15 percent of this map unit.

Permeability of this Nora soil is moderate. The available water capacity is high. The organic matter content is moderate, and natural fertility is medium. The soil ranges from slightly acid or neutral in the surface layer to mildly alkaline or moderately alkaline in the underlying material. The water intake rate is moderate. Runoff is slow. This soil is easy to work and keep in good tilth.

Most of the acreage of this soil is used as cropland. The remaining areas are in native grass and are used as rangeland.

Under dryland farming, this soil is suited to corn, sorghum, small grains, alfalfa, soybeans, and introduced grasses. Small grains and the first cutting of alfalfa are generally more dependable because they grow and mature in the spring when rainfall is highest. Conserving soil moisture is the main problem. A cropping system that includes stubble mulch tillage and summer fallow can conserve soil moisture and reduce soil blowing. Soil fertility can be increased by using barnyard manure.

Under irrigation, this soil is suited to corn, soybeans, sorghum, alfalfa, and introduced grasses. Gravity and sprinkler irrigation systems are suited to this soil. Where a gravity system is used, slight irregularities in the surface need to be leveled to secure uniform distribution of irrigation water. Close-growing crops and crop residue protect the soil against soil blowing. Returning crop residue to the soil helps to maintain and improve the organic matter content and fertility and increase the infiltration of water.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. Inadequate seasonal rainfall and competition for moisture from undesirable weeds and grasses are the main problems. Irrigation can provide supplemental moisture during dry periods. Weeds and grasses can be controlled by cultivating between the rows with conventional equipment and by careful use of appropriate herbicides.

This soil is generally suited to use for septic tank absorption fields and shallow excavations. Sewage lagoons need to be lined and sealed to prevent seepage. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarser-grained material for subgrade or base material can be used to ensure better performance. Damage to roads and streets by frost action can be reduced by providing good surface drainage. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This Nora soil is in capability units IIc-1 dryland and I-6 irrigated. It is in the Silty range site and windbreak suitability group 3.

NoC—Nora silt loam, 2 to 6 percent slopes. This deep, gently sloping, well drained soil is on ridgetops and hillsides of uplands. Individual areas range from 5 to 400 acres.

Typically, the surface layer is dark grayish brown, very friable silt loam about 7 inches thick. The subsoil is friable silt loam about 18 inches thick. The upper part is brown, and the lower part is pale brown and calcareous. The underlying material is very pale brown, calcareous silt loam to a depth of 60 inches or more. In places, the surface layer is lighter colored and less than 7 inches thick. In places, the surface layer is fine sandy loam or loam. In places, the subsoil and underlying material are

loam. In places, lime is below a depth of 30 inches. In a few places, siltstone is at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of Anselmo, Boelus, and Trent soils. Anselmo soils are higher on the landscape and contain more sand. Boelus soils are in similar landscape positions and are sandy in the upper part. Trent soils are dark to a depth of more than 20 inches and are in the swales. Included soils make up 10 to 15 percent of this map unit.

Permeability of this Nora soil is moderate. The available water capacity is high. The organic matter content is moderate, and natural fertility is medium. The soil ranges from slightly acid or neutral in the upper part to mildly alkaline or moderately alkaline in the lower part. Runoff is medium. The water intake rate is moderate. Tilth is generally good, and the soil is easily tilled.

Most of the acreage of this soil is cropland, and some of it is irrigated. The remaining acreage is in native grass and is used as rangeland.

Under dryland farming, this soil is suited to corn, small grains, sorghum, alfalfa, and introduced grasses. Where this soil is used for row crops, there are hazards of water erosion and soil blowing. Conservation practices, such as terraces, contour farming, grassed waterways, and a cropping system that includes stubble mulch tillage and good crop residue management are needed to control erosion. Returning crop residue to the soil increases the organic matter and improves fertility. Keeping the soil covered with crop residue helps to conserve soil moisture.

Under irrigation, this soil is suited to corn, sorghum, soybeans, alfalfa, and introduced grasses. Sprinkler and gravity irrigation systems are suited to this soil. The main problem in border and furrow irrigation is steepness of slopes. Bench leveling alters the surface of the land so that the soil has less slope and irrigation water flows slowly. The main problems with sprinkler irrigation are the moderate intake rate, runoff, and water erosion. Water erosion in the wheel tracks under center-pivot irrigation systems can be a problem. Stubble mulch tillage and terraces reduce erosion by water. Returning crop residue to the soil and adding manure increase the organic matter content and improve the water intake rate of the soil.

This soil is suited to rangeland. This use is effective in controlling erosion. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing, and a planned grazing system help to keep the range in good condition.

This soil is suited to trees and shrubs planted in windbreaks. All trees and shrubs that are moderately drought resistant are suited. Water erosion and moisture competition from grasses and weeds are the principal hazards for tree survival. Irrigation can provide supplemental moisture during periods of low rainfall. Trees can be planted on the contour in combination with terraces to help prevent erosion. Competition from undesirable grasses and weeds can be controlled by cultivation between the rows with conventional equipment and by the use of appropriate herbicides.

This soil is generally suited to use for septic tank absorption fields and shallow excavations. For sewage lagoons, grading is required to modify the slope and shape the lagoon. Sewage lagoons need to be lined and sealed to prevent seepage. Some buildings may need to be properly designed to accommodate the slope, or the soil can be graded to an acceptable gradient. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarser grained material for subgrade or base material can be used to ensure better performance. Damage by frost action can be reduced by providing good drainage. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This Nora soil is in capability units IIIe-1 dryland and IIIe-6 irrigated. It is in the Silty range site and windbreak suitability group 3.

OdB—O'Neill loamy sand, 0 to 3 percent slopes. This soil is nearly level to very gently sloping and well drained. It is moderately deep over gravelly coarse sand. The soil is on uplands and stream terraces. Individual areas range from 5 to 1,000 acres.

Typically, the surface layer is grayish brown, very friable loamy sand about 6 inches thick. The subsurface layer is dark grayish brown, very friable loamy sand about 4 inches thick. The subsoil is brown, very friable sandy loam about 15 inches thick. The underlying material is light yellowish brown, gravelly coarse sand to a depth of more than 60 inches. In places, the surface layer is sandy loam. In places, the lower part of the subsoil is clay loam or sandy clay loam. In places, the gravelly coarse sand is underlain by loamy material at a depth of 40 to 60 inches. In places, the subsoil and underlying material are fine sand, sand, or coarse sand.

Included with this soil in mapping are small areas of Anselmo, Jansen, and Valentine soils. Anselmo and Valentine soils are higher on the landscape and are sandy throughout. Jansen soils have a finer textured subsoil and are slightly lower on the landscape. Included soils make up 10 to 15 percent of the map unit.

Permeability of this O'Neill soil is moderately rapid in the subsoil and very rapid in the underlying material. The available water capacity is low. The organic matter content is moderately low, and natural fertility is medium. The soil is slightly acid or neutral. The water intake rate is high. Runoff is slow. This soil is easily tilled throughout a wide range of moisture content.

Most of the acreage of this soil is used as irrigated cropland. The rest is in native grass and is used for grazing or hayland.

Under dryland farming, this soil is poorly suited to corn, soybeans, small grains, alfalfa, and introduced grasses. Because available water capacity is low, small grains and first cutting of alfalfa are the most dependable crops. These crops grow and mature in spring when rainfall is most plentiful. Soil blowing is a hazard where the surface is not adequately protected by growing crops or crop residue. Conservation tillage practices, such as discing, that keep all or part of the crop residue on the surface help to prevent soil blowing and conserve moisture.

Under irrigation, this soil is suited to corn, soybeans, alfalfa, and introduced grasses. Sprinkler irrigation is best suited because frequent, light applications of water are needed. Excessive water leaches plant nutrients below the plant root zone. Soil blowing is a hazard where the surface is not adequately protected by growing crops or crop residue. This hazard can be reduced by stripcropping, stubble mulch tillage, and a cropping system that keeps all or part of the crop residue on the soil surface.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. Because the available water capacity is low, only drought resistant trees and shrubs are suited. Supplemental water may be needed to overcome drought conditions. Moisture competition from weeds and grasses can be controlled by cultivation between the rows with conventional equipment. Hoeing by hand or careful use of appropriate herbicides can control weeds in the row.

This soil is generally suited to use as sites for dwellings and small commercial buildings. If this soil is used for septic tank absorption fields, care should be taken so that pollution by seepage does not contaminate nearby water supplies. This soil readily absorbs effluent from absorption fields, but it does not adequately filter the effluent. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Damage to roads and streets by frost action can be reduced by providing good surface drainage. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This O'Neill soil is in capability units IVe-5 dryland and IIIe-14 irrigated. It is in the Sandy range site and windbreak suitability group 6G.

Oe—O'Neill fine sandy loam, 0 to 2 percent slopes. This nearly level, well drained soil is on uplands and stream terraces. It is moderately deep over coarse sand. Individual areas range from 5 to 2,000 acres.

Typically, the surface layer is grayish brown, very friable fine sandy loam about 8 inches thick. The subsurface layer is dark grayish brown, very friable fine sandy loam about 4 inches thick. The subsoil is brown, very friable fine sandy loam about 14 inches thick. The underlying material is pale brown sand in the upper part and very pale brown coarse sand in the lower part. It extends to a depth of 60 inches or more. In places, the surface layer is loamy sand. In a few places, this soil is dark to a depth of more than 20 inches. In places, a 6- to 12-inch layer of sandy clay loam is in the lower part of the subsoil above the coarse sand. In places, the underlying material is loamy fine sand or fine sand.

Included with this soil in mapping are small areas of Dunday, Jansen, Meadin, and Pivot soils. Dunday soils are higher on the landscape and are sandy throughout the profile. Jansen and Pivot soils are in similar positions on the landscape. Jansen soils have a finer textured subsoil. Pivot soils have a sandier subsoil. Meadin soils are lower on the landscape and have gravelly coarse sand at a depth of 8 to 20 inches. Included soils make up 10 to 15 percent of the map unit.

Permeability of this O'Neill soil is moderately rapid in the subsoil and very rapid in the underlying material. The available water capacity is low. Natural fertility is medium, and the organic matter content is moderately low. The soil is strongly acid to neutral. The water intake rate is moderately high. Runoff is slow. Tilth is generally good, and the soil is easily tilled.

Most of the acreage of this soil is cropland. The remaining acreage is in native grass and is used as rangeland. A large acreage of the cropland is irrigated.

Under dryland farming, this soil is suited to corn, sorghum, soybeans, small grains, alfalfa, and introduced grasses. Soil blowing is the main hazard where the surface is not adequately protected by growing crops or crop residue. Conservation tillage practices, such as discing and chiseling, can be used to keep all or part of the crop residue on the surface of the soil to help prevent soil blowing and conserve soil moisture. This soil is droughty because of the low available water capacity. Adding barnyard manure and returning available crop residue to the soil help to maintain organic matter content and soil fertility.

Under irrigation, this soil is suited to corn, sorghum, soybeans, alfalfa, and introduced grasses. Sprinkler and gravity irrigation systems are suitable for this soil. For gravity irrigation systems, some land grading generally is needed. Where deep cuts are made into the gravelly coarse sand underlying material, backfilling with finer textured material may be needed. Light, frequent applications of irrigation water are needed. Soil blowing is a serious hazard. Soil blowing can be reduced and soil

moisture conserved by stubble mulch tillage and cropping systems that keep the soil covered with crops or crop residue most of the time. Adding barnyard manure to the soil increases the organic matter content and improves natural fertility and the water intake rate.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock or improper haying methods reduce the protective cover and cause deterioration of the potential native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. Inadequate seasonal rainfall is a limitation for planting trees. Supplemental water may need to be supplied by irrigation. This soil has low available water capacity, and only those trees and shrubs that are drought tolerant are suitable. Moisture competition from grasses and weeds can be controlled by good site preparation, timely cultivation, and use of herbicides.

This soil is generally suited to use as sites for dwellings and small commercial buildings. This soil readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent. The poor filtering capacity can result in pollution of nearby water supplies. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Damage to roads and streets by frost action can be reduced by providing good surface drainage. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This O'Neill soil is in capability units IIIe-3 dryland and IIIe-9 irrigated. It is in the Sandy range site and windbreak suitability group 6G.

OeC—O'Neill fine sandy loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on uplands and stream terraces. It is moderately deep over coarse sand. Individual areas range from 5 to 200 acres.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 12 inches thick. The subsoil is about 14 inches thick. It is dark brown, very friable fine sandy loam in the upper part and brown, very friable sandy loam in the lower part. The underlying material is very pale brown coarse sand to a depth of 60 inches or more. In places, the surface layer is loam or loamy sand. In places, the underlying material is sand or fine sand. In a few places, the surface layer is more than 20 inches thick.

Included with this soil in mapping are small areas of Jansen, Meadin, and Pivot soils. These soils are in similar positions on the landscape. Jansen soils have a finer textured subsoil. Pivot soils contain more sand. Meadin soils have gravelly coarse sand at a depth of 8 to 20 inches. Included soils make up 10 to 15 percent of this map unit.

Permeability of this O'Neill soil is moderately rapid in the subsoil and very rapid in the underlying material. The available water capacity is low. Natural fertility is medium, and the organic matter content is moderately low. The soil is strongly acid to neutral. The water intake rate is moderately high. Runoff is slow to medium. This soil is easy to work and keep in good tilth.

Most of the acreage of this soil is in native grass and is used for grazing. The rest is used as cropland under dryland and irrigation management.

Under dryland farming, this soil is poorly suited to corn, sorghum, soybeans, small grains, and alfalfa. Soil blowing and water erosion are hazards. These hazards can be reduced and moisture conserved if stubble mulch tillage practices are used and the soil is kept covered with crops or crop residue most of the time. Contour farming helps to prevent water erosion. Adding barnyard manure to the soil improves fertility. Stripcropping reduces soil blowing.

Under irrigation, this soil is suited to corn, sorghum, soybeans, alfalfa, and introduced grasses. This soil is best suited to sprinkler irrigation. Frequent, light applications of irrigation water are needed. Contour farming, stripcropping, and stubble mulch tillage reduce water erosion. Discing and other tillage practices that keep the crop residue at the surface help to control erosion, conserve moisture, and increase the water intake rate. Adding barnyard manure to the soil helps to maintain fertility and increase the organic matter content.

This soil is suited to rangeland. This use is effective in controlling soil blowing and water erosion. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. The low available water capacity makes this soil droughty. Only those trees and shrubs that are tolerant are suited unless supplemental water is supplied by irrigation. Competition from grasses and weeds can be controlled by cultivation. Areas near the trees can be rototilled or hoed by hand. Soil blowing can be controlled by maintaining strips of sod between the rows.

This soil is generally suited to use as dwelling sites. This soil readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent. The poor filtering capacity can result in pollution of nearby water supplies. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Small commercial buildings may need to be properly designed to accommodate the slope, or the soil can be graded to an acceptable gradient. Damage to roads by frost action can be

reduced by providing good surface drainage. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This O'Neill soil is in capability units IVe-3 dryland and IVe-9 irrigated. It is in the Sandy range site and windbreak suitability group 6G.

Of—O'Neill loam, 0 to 2 percent slopes. This nearly level, well drained soil is moderately deep over coarse sand and gravelly coarse sand. It is on uplands. Individual areas range from 5 to 1,000 acres.

Typically, the surface layer is dark gray, very friable loam about 8 inches thick. The very friable subsoil is about 18 inches thick. It is dark grayish brown fine sandy loam in the upper part and brown sandy loam in the lower part. The underlying material is pale brown coarse sand in the upper part and very pale brown, gravelly coarse sand in the lower part. It extends to a depth of more than 60 inches. In places, the surface layer is silt loam or fine sandy loam. In some areas, a 3- to 6-inch loamy or clayey layer is in the lower part of the subsoil above the gravelly coarse sand. In places, the underlying material is loamy fine sand or fine sand.

Included with this soil in mapping are small areas of Jansen and Meadin soils. Jansen soils are in similar positions and have a finer textured subsoil. Meadin soils are lower on the landscape and have gravelly coarse sand at a depth of 8 to 20 inches. Included soils make up 10 to 15 percent of the map unit.

Permeability of this O'Neill soil is moderately rapid in the subsoil and very rapid in the underlying material. The available water capacity is low. The organic matter content is moderate, and natural fertility is medium. The soil is slightly acid or neutral. The water intake rate is moderate. Runoff is slow. Tilth is generally good, and the soil is easily tilled.

Most areas of this soil are in cropland under dryland or irrigation management. The remaining acreage is in native grass.

Under dryland farming, this soil is suited to corn, soybeans, small grains, alfalfa, and introduced grasses. This soil is droughty, and rainfall is limited during the growing season. Small grains and the first cutting of alfalfa are generally more dependable crops because they grow and mature in spring when rainfall is highest. Crop residue kept on the surface during tillage helps to reduce evaporation and increase the water intake of the soil. The use of barnyard manure and crop residue also helps to maintain good tilth.

Under irrigation, this soil is suited to corn, alfalfa, soybeans, and introduced grasses. Land grading is needed for a more nearly uniform application of water if areas are to be irrigated by gravity methods. Sprinkler irrigation is well suited to this soil. Fertility can be maintained by returning crop residue to the soil, growing legumes, and using barnyard manure.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. Trees and shrubs that are drought-tolerant are best suited. Moisture competition from grasses and weeds and droughty conditions are the principal hazards to seedling establishment. Trees need to be irrigated during prolonged dry periods. Weeds and undesirable grasses can be controlled by cultivation and timely use of herbicides.

This soil is generally suited to use for dwellings and small commercial buildings. Where this soil is used for septic tank absorption fields, care should be taken so that pollution by seepage does not contaminate nearby water supplies. The soil readily absorbs effluent from absorption fields, but it does not adequately filter the effluent. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Damage to roads and streets by frost action can be reduced by providing good surface drainage. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This O'Neill soil is in capability units IIc-1 dryland and IIs-7 irrigated. It is in the Sandy range site and windbreak suitability group 6G.

OmC—O'Neill-Meadin fine sandy loams, 2 to 6 percent slopes. These gently sloping soils are on upland side slopes and along drainageways. The O'Neill soil is well drained and moderately deep over coarse sand and gravelly coarse sand. The Meadin soil is excessively drained and shallow over gravelly coarse sand. This complex is about 60 to 75 percent O'Neill soil and 15 to 30 percent Meadin soil. The O'Neill soil is on the concave, middle and lower side slopes. The Meadin soil is on convex, upper side slopes and ridgetops. The two soils are so intricately mixed that it was not practical to separate them in mapping. Individual areas range from 5 to 1,000 acres.

Typically, the O'Neill soil has a dark gray, very friable fine sandy loam surface layer about 5 inches thick. The subsurface layer is dark grayish brown, very friable fine sandy loam about 7 inches thick. The subsoil, about 14 inches thick, is grayish brown, very friable fine sandy loam in the upper part and brown, very friable sandy loam in the lower part. The underlying material is light yellowish brown, gravelly coarse sand to a depth of more than 60 inches. In places, the surface layer is loam, sandy loam, or loamy sand. In a few places, the underlying material is loamy fine sand, sand, or coarse

sand. In some eroded places, the surface layer is thin and light colored.

Typically, the Meadin soil has a dark grayish brown, very friable fine sandy loam surface layer about 8 inches thick. The transitional layer is brown, very friable sandy loam about 7 inches thick. The underlying material is light yellowish brown, gravelly coarse sand to a depth of more than 60 inches. In places, the surface layer is loam or loamy sand. In a few areas, the gravelly coarse sand is at a depth of less than 8 inches.

Included with these soils in mapping are small areas of Dunday, Jansen, Paka, and Pivot soils. Dunday soils are on lower side slopes and are sandy throughout. Jansen and Pivot soils are in similar positions on the landscape. Jansen soils have a finer textured subsoil. Pivot soils contain more sand. Paka soils are lower on the landscape and are silty throughout. Included soils make up 10 to 20 percent of the map unit.

Permeability in the O'Neill soil is moderately rapid in the subsoil and very rapid in the underlying material. Permeability in the Meadin soil is rapid in the upper part and very rapid in the lower part. The available water capacity is low in both soils. The O'Neill soil has medium natural fertility, and the organic matter content is moderately low. The organic matter content in the Meadin soil is moderately low, and natural fertility is low. The O'Neill soil is slightly acid to neutral, and the Meadin soil is strongly acid to neutral. Runoff is slow to medium in both soils. The water intake rate is moderately high in the O'Neill soil and high in the Meadin soil.

Most of the acreage of this complex is in native grass and is used as range. The rest is used as cropland, mostly under irrigation management.

Under dryland farming, this complex is poorly suited to corn, soybeans, small grains, alfalfa, and introduced grasses. These soils are so intermixed that they cannot be managed separately. Crop response on the areas of Meadin soil is poor, and growth is spotty. The main hazards are soil blowing and water erosion. Alternating row crops with small grains, using stubble mulch tillage, and keeping the soil covered with crops or crop residue most of the time reduce soil blowing and water erosion. Contour farming helps to prevent water erosion. Additions of barnyard manure increase the organic matter content and improve fertility.

Under irrigation, this complex is poorly suited to corn, soybeans, alfalfa, and introduced grasses. Sprinkler irrigation is best suited to these soils. The Meadin soil has a shallow root zone. Both soils need frequent, light applications of irrigation water. If too much water is used, leaching of nutrients is a problem. Soil blowing and water erosion are hazards. These hazards can be controlled by keeping the soil covered with crops or crop residue. Contour farming, stripcropping, and stubble mulch tillage reduce water erosion. Returning crop residue to the soil and adding barnyard manure increase the organic matter content.

This complex is suited to rangeland. This use is effective in controlling soil blowing and water erosion. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve the range condition.

The O'Neill soil is suited to drought-tolerant trees and shrubs planted in windbreaks. The Meadin soil is unsuited to windbreak plantings because of a shallow root zone and low available water capacity. Onsite investigation is needed to select suitable sites for trees and shrubs. These soils are so intermixed they cannot be managed separately. Inadequate rainfall is the main hazard to seedling establishment. Drought-tolerant species should be planted. Moisture competition from weeds and grasses can be controlled by cultivation between the rows with conventional equipment. Careful use of herbicides or hoeing by hand can control weeds in the row. Irrigation can provide supplemental moisture during periods of insufficient rainfall.

These soils are generally suited to use as sites for dwellings. Where these soils are used for septic tank absorption fields, care should be taken so that pollution by seepage does not contaminate nearby water supplies. These soils readily absorb effluent from absorption fields, but they do not adequately filter the effluent. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Small commercial buildings may need to be designed to accommodate the slope, or the soil can be graded to an acceptable gradient. On the O'Neill soil, damage to roads and streets by frost action can be reduced by providing good surface drainage. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage. The Meadin soil is generally suited to use for local roads and streets.

This complex is in capability units IVs-4 dryland and IVs-14 irrigated. The O'Neill soil is in the Sandy range site and windbreak suitability group 6G. The Meadin soil is in the Shallow to Gravel range site and windbreak suitability group 10.

OmD—O'Neill-Meadin fine sandy loams, 6 to 11 percent slopes. These strongly sloping, well drained and excessively drained soils are on upland side slopes and along drainageways. The O'Neill soil is moderately deep over coarse sand and gravelly coarse sand, and the Meadin soil is shallow over gravelly coarse sand. About 50 to 65 percent of this complex is O'Neill soil and 20 to 35 percent is Meadin soil. The O'Neill soil is on the concave, mid and lower side slopes. The Meadin soil is mostly on the convex, upper side slopes or shoulders and on narrow ridgetops. The two soils are so intricately mixed that it was not practical to separate

them in mapping. Individual areas of this complex range from 5 to 1,000 acres.

Typically, the O'Neill soil has a dark gray, very friable fine sandy loam surface layer about 11 inches thick. The subsoil is grayish brown, very friable sandy loam about 13 inches thick. The underlying material is light yellowish brown coarse sand in the upper part. The lower part is very pale brown, gravelly coarse sand to a depth of more than 60 inches. In places, the surface layer is loam or loamy sand. In a few places, the surface layer is less than 7 inches thick. In a few areas, the underlying material is sand.

Typically, the Meadin soil has a dark gray, very friable fine sandy loam surface layer about 8 inches thick. The transitional layer is grayish brown, very friable sandy loam about 6 inches thick. The underlying material is yellowish brown, gravelly coarse sand to a depth of more than 60 inches. In places, the surface layer is loam or loamy sand. In a few areas, the gravelly coarse sand is at a depth of less than 8 inches.

Included with these soils in mapping are small areas of Jansen, Paka, and Pivot soils. These soils are in similar positions on the landscape. Jansen soils have a finer textured subsoil. Pivot soils have a sandier subsoil. Paka soils are silty throughout. Included soils make up 10 to 15 percent of the map unit.

Permeability in the O'Neill soil is moderately rapid in the solum and very rapid in the underlying material. Permeability in the Meadin soil is rapid in the upper part and very rapid in the lower part. The available water capacity is low in both soils. The O'Neill soil has medium natural fertility and moderately low organic matter content. The Meadin soil has moderately low organic matter content and low natural fertility. The O'Neill soil is slightly acid or neutral, and the Meadin soil is strongly acid to neutral. Runoff is medium in both soils.

Under dryland farming, this complex is unsuited to cultivation because the soils are too shallow, droughty, and subject to water erosion.

Under irrigation, this complex is poorly suited to alfalfa and introduced grasses. Row crops are not well suited because of the steep slopes. Gravity irrigation is not suitable because of sandiness and steepness of slope. Wheel track erosion can be a problem under sprinkler irrigation by center pivots. Soil blowing and water erosion are hazards if the surface is not protected. Contour farming and a cropping system that keeps the soils covered with crops, grass, or crop residue most of the time need to be used to control runoff and erosion. Returning crop residue to the soil and using barnyard manure increase the organic matter content and improve fertility.

The O'Neill soil is suited to trees and shrubs planted in windbreaks. The Meadin soil is unsuited to windbreak plantings because of a shallow root zone and low available water capacity. These soils are so intermixed they cannot be managed separately. Before planning a windbreak, onsite investigations are needed. Inadequate rainfall is the main hazard to seedling establishment. Drought-tolerant species should be planted. Moisture competition from weeds and grasses can be controlled by cultivation between the rows with conventional equipment. Careful use of herbicides or hoeing by hand can control weeds in the row. Use of herbicides may cause problems because of leaching. Irrigation can provide supplemental moisture during periods of insufficient rainfall.

Where these soils are used for septic tank absorption fields, care should be taken so that pollution by seepage does not contaminate nearby water supplies. These soils readily absorb effluent from absorption systems, but they do not adequately filter the effluent. Sewage lagoons need to be lined or sealed to prevent seepage. Grading is required to modify the slope and shape the lagoon. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Dwellings and small commercial buildings need to be properly designed to accommodate the slope, or these soils can be graded to an acceptable gradient. Cuts and fills are generally needed to provide a suitable grade for roads and streets. On the O'Neill soil, damage to roads and streets by frost action can be reduced by providing good surface drainage. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This complex is in capability units VIs-4 dryland and IVs-14 irrigated. The O'Neill soil is in the Sandy range site and windbreak suitability group 6G. The Meadin soil is in the Shallow to Gravel range site and windbreak suitability group 10.

OmF—O'Neill-Meadin fine sandy loams, 11 to 30 percent slopes. These well drained and excessively drained, moderately steep and steep soils are on uplands. The O'Neill soil is moderately deep over coarse sand or gravelly coarse sand, and the Meadin soil is shallow over gravelly coarse sand. These soils are mainly on side slopes along drainageways. This complex is about 40 to 55 percent O'Neill soil and about 20 to 45 percent Meadin soil. The O'Neill soil is on the concave, mid and lower side slopes. The Meadin soil is mostly on the convex, upper side slope shoulders and narrow ridgetops. The two soils are so intricately mixed it was not practical to separate them in mapping. Individual areas range from 5 to 500 acres.

Typically, the O'Neill soil has a dark grayish brown, very friable, fine sandy loam surface layer about 9 inches thick. The subsoil is brown, very friable sandy loam about 13 inches thick. The underlying material is very pale brown, gravelly coarse sand to a depth of more than 60 inches. In places, the surface layer is loamy sand. In places, the surface layer is less than 7 inches thick. In places, the underlying material is sand or fine sand.

Typically, the Meadin soil has a dark grayish brown, very friable, fine sandy loam surface layer about 7 inches thick. The transitional layer is brown, very friable gravelly sandy loam about 5 inches thick. The underlying material is light yellowish brown, gravelly coarse sand to a depth of more than 60 inches. In places, the surface layer is loam or loamy sand. In places, the gravelly coarse sand is at a depth of less than 8 inches.

Included with these soils in mapping are small areas of Brunswick, Dunday, Inavale, Jansen, Pivot, and Simeon soils. Brunswick, Dunday, Jansen, Pivot, and Simeon soils are in similar positions on the landscape. Brunswick soils have sandstone at a depth of 20 to 40 inches. The Dunday and Simeon soils are deep and sandy throughout the profile. Pivot soils contain more sand than O'Neill soils. Jansen soils have a more clayey subsoil than the O'Neill soils. Inavale soils are deep, sandy soils on the bottom lands along drainageways. Included soils make up 10 to 15 percent of the map unit.

Permeability in the O'Neill soil is moderately rapid in the solum and very rapid in the underlying material. Permeability in the Meadin soil is rapid in the upper part and very rapid in the lower part. The available water capacity is low in both soils. The O'Neill soil has medium natural fertility and moderately low organic matter content. Natural fertility is low and the organic matter content is moderately low in the Meadin soil. Both soils are strongly acid to neutral. Runoff is medium to rapid.

Areas of this complex are in native grass and are used as rangeland.

These soils are unsuited to cropland because of the steep slopes.

This complex is suited to rangeland. This use is effective in controlling soil blowing and water erosion. Overgrazing reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing, and planned grazing systems help to maintain or improve the range condition.

This complex is generally unsuited to shrubs and trees planted in windbreaks. Some areas can be used for recreational, wildlife, or forestation plantings of tolerant trees and shrubs if they are planted by hand or other approved special practices are used.

These soils generally are not suited to sanitary facilities because of the steep slopes. A suitable alternate site is needed. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. The slope increases the difficulty of digging. Cuts and fills are generally needed to provide a suitable grade for roads and streets. Damage to roads by frost action in the O'Neill soil can be reduced by providing good surface drainage. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This complex is in capability unit VIe-3 dryland. The O'Neill soil is in the Sandy range site, and the Meadin soil is in the Shallow to Gravel range site. Both soils are in windbreak suitability group 10.

Or—Ord loam, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on bottom lands. Areas are rarely flooded. Individual areas range from 10 to 1,000 acres or more.

Typically, the surface layer is calcareous, gray, very friable loam about 12 inches thick. The subsurface layer is calcareous, dark gray, very friable fine sandy loam about 5 inches thick. The transitional layer is light brownish gray, very friable fine sandy loam about 7 inches thick. The underlying material is light gray sand to a depth of more than 60 inches. It has yellowish brown mottles and thin strata of loamy fine sand. In places, the surface layer is fine sandy loam or sandy clay loam. In places, the surface layer is noncalcareous. In a few places, the underlying material is coarse sand below a depth of 30 inches. In a few places, layers of loamy material are below a depth of 20 inches.

Included with this soil in mapping are small areas of Cass, Elsmere, Gannett, Loup, and Lex soils. Cass soils are higher on the landscape and are well drained. Elsmere and Lute soils are in similar positions on the landscape. Elsmere soils contain more sand. Lex soils are finer textured. Gannett and Loup soils are lower on the landscape and are poorly drained or very poorly drained. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Ord soil is moderately rapid in the upper part and rapid in the lower part. The available water capacity is moderate, and the organic matter content is moderate. Natural fertility is medium, and runoff is slow. The water intake rate is moderately high. The soil is neutral through moderately alkaline. The seasonal high water table ranges from a depth of 1.5 feet in wet years to 2.5 feet in dry years.

Most of the acreage of this soil is in native grass and is used as range or hayland. The remaining acreage is used as cropland.

Under dryland farming, this soil is suited to corn, sorghum, soybeans, alfalfa, small grains, and introduced grasses. Spring-sown small grains are not well suited because the water table is usually highest in the spring. Wetness delays seedbed preparation. The water table can drown out alfalfa in low spots, but growing alfalfa and winter wheat eliminates the need to till in the spring when the soil is wet. Drainage ditches or tile drains can be used to lower the water table. Returning crop residue to the soil helps to maintain the organic matter content. Adding barnyard manure helps to maintain and improve fertility.

Under irrigation, this soil is suited to corn, sorghum, soybeans, alfalfa, and introduced grasses. Land leveling is generally needed if furrows and borders are used for irrigating. Sprinkler irrigation is well suited to this soil. This soil is slow to dry out in the spring, and tillage

operations can be delayed because of wetness. Tiling is normally not required for irrigation, but the water table can be a problem in wet periods. If suitable outlets are available, drainage ditches or tile drains can be used to lower the water table. Crop residue left on the surface in winter protects this soil from blowing.

This soil is suited to rangeland, either for grazing or haying. This use is effective in controlling soil blowing. Overgrazing, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. If the soil is wet, overgrazing can cause surface compaction and small mounds, making it difficult to graze or harvest for hay. Proper grazing use, timely deferment from grazing or haying, and restricted use during very wet periods help to maintain the native plants in good condition.

Mowing needs to be regulated so that the grasses remain vigorous and healthy where this soil is used as hayland. In order to allow for carbohydrate storage in the grass plants, mowing should be avoided between boot stage and seed maturity. Most ranchers mow before the seed head is in the boot stage or after seed has matured. Additions of nitrogen and phosphate fertilizers can increase hay production. After frost and during winter, range animals can graze meadows without damage if areas are properly stocked.

This soil is suited to trees planted in windbreaks. Only trees and shrubs that are tolerant of a moderately high water table are suited. Establishment of seedlings can be a problem during wet years. The soil should be tilled and seedlings planted after the soil dries out. The abundant and persistent herbaceous vegetation that grows on this soil is a concern because it competes with the trees. Weeds and grasses can be controlled by cultivation between the rows with conventional tillage equipment and by timely use of herbicides. Areas near trees can be rototilled or hoed by hand.

Septic tank absorption fields can be constructed on fill material so that the absorption field is placed a sufficient distance above the seasonal high water table. Care should be taken so that pollution by seepage does not contaminate the underground water table. Sewage lagoons need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal high water table. Sewage lagoons need to be lined or sealed to prevent seepage. Digging during dry periods is easier and helps to avoid caving and water problems. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing and caving. Dwellings and buildings need to be constructed on raised, well compacted fill material to overcome wetness caused by the high water table and flooding. Damage to roads by frost action can be reduced by providing good surface drainage and by the use of a gravel moisture barrier in the subgrade. Crowning the road by grading provides needed surface drainage

This Ord soil is in capability units IIw-4 dryland and IIw-8 irrigated. It is in the Subirrigated range site and windbreak suitability group 2S.

Os—Ord-Lute fine sandy loams, 0 to 2 percent slopes. These deep, nearly level, somewhat poorly drained soils are on bottom lands. These soils are rarely flooded. About 40 to 55 percent of the complex is Ord soil and 20 to 35 percent is Lute soil. These soils are in similar positions on the landscape. Areas of Lute soil are irregular in shape and range from about 10 to 100 feet across. They are surrounded by the larger areas of Ord soil. The two soils are so intricately mixed that it was not practical to separate them in mapping. Individual areas of this complex range from about 10 to 1,000 acres.

Typically, the Ord soil has a dark gray, very friable, calcareous, fine sandy loam surface layer about 8 inches thick. The subsurface layer is similar to the surface layer in color and texture and is about 6 inches thick. The transitional layer is mottled, grayish brown, very friable fine sandy loam about 12 inches thick. It is stratified with layers of loamy sand and loam. The underlying material is light gray fine sand to a depth of more than 60 inches. It has yellowish brown mottles. In places, the surface layer is loam or sandy clay loam. In places, layers of loamy material are below a depth of 20 inches.

Typically, the Lute soil has a surface layer of gray, very friable fine sandy loam about 3 inches thick. The subsoil is calcareous fine sandy loam about 23 inches thick. It is dark gray in the upper part, grayish brown in the middle part, and mottled light brownish gray in the lower part. The subsoil is friable when moist and very hard when dry. The underlying material is light gray fine sand to a depth of more than 60 inches. It is stratified with thin layers of loam to loamy sand and has dark brown mottles. In some areas, the surface layer is loamy fine sand or fine sand. In places, the subsoil is sandy clay loam. In a few places, layers of loamy material are below a depth of 20 inches.

Included with these soils in mapping are small areas of Elsmere, Gannett, Lawet, Lex, and Selia soils. Elsmere, Lawet, Lex, and Selia soils are in similar landscape positions. Elsmere soils contain more sand than Ord soils. Lawet and Lex soils are finer textured. Selia soils are sandier than Lute soils. Gannett soils are in lower positions on the landscape and are poorly drained or very poorly drained. Included soils make up 10 to 15 percent of the map unit.

Permeability in the Ord soil is moderately rapid in the upper part and rapid in the lower part. Permeability in the Lute soil is slow in the subsoil and rapid in the underlying material. The available water capacity is moderate in both soils. In the Ord soil, the organic matter content is moderate and natural fertility is medium. In the Lute soil, the organic matter content and natural fertility are low. Runoff is slow to very slow, and some areas of the Lute soil in microdepressions are ponded. The Ord soil is

slightly acid to moderately alkaline in the upper part and neutral to moderately alkaline in the lower part. The Lute soil is strongly alkaline or very strongly alkaline except in the surface layer, which ranges from neutral to moderately alkaline. The Lute soil is high in sodium content. The seasonal high water table in these soils ranges from a depth of 1.5 feet in wet years to about 2.5 feet in dry years. Lute soil takes in water slowly and releases it slowly to plants. It has poor soil structure and becomes very hard when dry. Ord soil is easily tilled, and tilth is generally good. Lute soil is difficult to work and keep in good tilth.

Most of the acreage of this complex is in native grass and is used as range or hayland. The remaining acreage is used for cultivated crops, and a few areas are irrigated.

Under dryland farming, this complex is poorly suited to corn, sorghum, and small grains. Alfalfa and alkali-tolerant grasses are better suited than most other plants. The principal limitations are alkalinity, maintenance of fertility, and the hazard of soil blowing. Crops do not grow well on the areas of Lute soil because of the alkali. Lute soil is difficult to till. When it is dry, this soil is light colored and cloddy. The seasonal high water table, early in spring, causes wetness that delays tillage and causes the soil to warm up slowly. During dry periods, the water table provides subirrigation. Fertility needs to be balanced because the alkalinity in the Lute soil makes many of the nutrients unavailable to plants. Adding barnyard manure to the Lute soil helps make it more friable and increases water intake. Cover crops or crop residue left on the surface in winter helps to control soil blowing. Growing legumes and returning crop residue to the soil increase the organic matter content and improve soil fertility.

Under irrigation, this complex is poorly suited to corn and sorghum. Alfalfa and alkali-tolerant grasses can be grown. Gravity methods of irrigation require some land grading. Some grading generally needs to be done on sprinkler irrigated fields to improve surface drainage. Water from rain and irrigation can stand on the surface in some of the alkali spots for several days if the area is not graded and smoothed. Applications of water need to be frequent and light. Crop residue left on the surface in winter helps to protect these soils from soil blowing. Normally, tiling is not required, but wetness from the seasonal high water table is a concern of management early in spring and during periods of above normal rainfall. These soils dry out slowly in the spring, causing delays in tillage operations. Plant nutrients are less available in Lute soil than in the Ord soil, and aeration is poor. Soil fertility can be improved by growing legumes, returning crop residue to the soil, and using barnyard manure. Adding manure and other forms of organic matter in large quantities to the Lute soil help to make the soil more friable and increase the rate of water intake. Additions of chemicals are needed to neutralize the alkali in the Lute soil.

The reclamation of alkali soils is difficult, expensive, and time consuming. Technical help is needed before reclamation is begun, and the area needs to be fully investigated.

The alkali condition can be improved by adding chemical amendments, leaching the soil, and using practices that build soil structure. Chemical amendments, such as gypsum and sulfur, are expensive. It is good practice to determine the kind and amount of amendments on the basis of chemical soil tests. The common method of leaching is to pond water over the alkali area. The amount of leaching water that enters the soil determines how much salt is removed from the soil. Leaching is not successful if the water table is too high. The water table needs to be lowered to a depth of 4.5 to 5 feet during the growing season. Where suitable outlets are available, tile drains or open ditches can be used to lower the water table. Applications of manure or other forms of organic matter are needed to help improve the soil structure after chemical treatment and leaching are completed.

This complex is suited to native grasses used for grazing or hay production. However, the alkali problems are not easily controlled. Ranchers can usually make allowances as needed in the grazing usage and mowing patterns to fit condition of the alkali soils. Overgrazing by livestock, improper haying methods, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. If the soils are wet, overgrazing can cause boggy conditions to develop. Proper grazing use, timely deferment from grazing or haying, and restrictive use during wet periods help to maintain the native plants in good condition.

Mowing needs to be regulated so that the grasses remain vigorous where this complex is used as hayland. A proper mowing sequence should be followed. The meadows should be cut before the dominant grasses reach the boot stage. Mowing should be avoided between boot stage and seed maturity. After frost and during winter, range animals can graze the meadows without damage if the areas are properly stocked.

The Ord soil is suited to trees and shrubs planted in windbreaks. The Lute soil is poorly suited. Because of the intermixed composition of these soils, the complex should be treated as one unit. Capacity for survival and growth of adapted species is good in the Ord soil if the species selected can tolerate occasional wetness from the water table. In the Lute soil, capacity for survival and growth of adapted species is poor. Only trees and shrubs that can tolerate occasional wetness and alkali conditions are suited. In wet years, the planting of seedlings can be delayed until the soils are sufficiently dry. The effect of alkali can be minimized by using salt-tolerant species. The abundant and persistent herbaceous vegetation that grows on these soils is a

concern because it competes with the trees. Weeds and grasses between the rows can be controlled by cultivation and use of appropriate herbicides. Areas in the rows and close to the trees can be rototilled or hoed by hand.

Septic tank absorption fields can be constructed on fill material so that the absorption field is placed a sufficient distance above the seasonal high water table. Care should be taken on the Ord soil so that pollution by seepage does not contaminate the underground water table. Sewage lagoons need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal high water table. Sewage lagoons need to be lined or sealed to prevent seepage. Digging during dry periods is easier and helps to avoid caving and water problems. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing and caving. Dwellings and buildings can be constructed on elevated, well compacted fill material as protection against flooding and to overcome wetness caused by the high water table. Damage to roads by frost action can be reduced by providing good surface drainage and by the use of a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This complex is in capability units IVs-1 dryland and IVs-8 irrigated. The Ord soil is in the Subirrigated range site and windbreak suitability group 2S. The Lute soil is in the Saline Subirrigated range site and windbreak suitability group 9S.

Pg—Paka fine sandy loam, 0 to 2 percent slopes. This deep, nearly level, well drained soil is on uplands. This soil is in areas that have loamy eolian material deposited over silty and loamy material weathered from siltstone. Individual areas range from 5 to 100 acres.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 7 inches thick. The subsurface layer is dark gray, very friable fine sandy loam about 3 inches thick. The subsoil is about 22 inches thick. The upper part is brown clay loam, the middle part is pale brown silty clay loam, and the lower part is light gray, calcareous silt loam. The underlying material, about 12 inches thick, is calcareous, white silt loam. White, calcareous siltstone is at a depth of 44 inches. In places, the surface layer is loamy fine sand or loam. In places, the subsoil is loam or sandy clay loam. In places, the underlying material is sandstone, and, in a few places, the sandstone is at a depth of less than 40 inches.

Included with this soil in mapping are small areas of Anselmo, Boelus, Brunswick, and Dunday soils. Anselmo, Boelus, and Dunday soils formed in sandier material and are higher on the landscape. Brunswick soils are in similar positions and have a subsoil that contains more sand. Included soils make up 10 to 15 percent of this map unit.

Permeability of this Paka soil is moderate, and the available water capacity is high. The organic matter content is moderately low, and natural fertility is medium. The water intake rate is moderate. Runoff is slow. The soil is neutral to moderately alkaline. This soil is easy to till and keep in good tilth.

A large acreage of this soil is in cropland. The remaining areas are in native grass and are used as rangeland.

Under dryland farming, this soil is suited to corn, small grains, soybeans, sorghum, and alfalfa. Soil blowing is a hazard. Crop residue kept on the surface during tillage helps to reduce evaporation, conserve moisture, and increase water intake of the soil. Stripcropping reduces the soil blowing. Adding barnyard manure and returning crop residue to the soil help to increase organic matter content and improve fertility.

Under irrigation, this soil is suited to corn, sorghum, small grains, soybeans, and alfalfa. Gravity or sprinkler methods of irrigation are suited. Soil blowing is a hazard. Conservation tillage practices, such as discing or chiseling, and till-plant systems keep all or most of the crop residue on the surface. These practices help to control soil blowing, conserve moisture, and improve the water intake rate.

This soil is suited to rangeland, either grazing or haying. This use is effective in controlling soil blowing. Overgrazing by livestock and improper timing of haying reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. Soil blowing can be controlled by maintaining strips of sod or a cover crop between the row. Trees need to be irrigated during extended dry periods. Cultivation to control undesirable grasses and weeds needs to be restricted to the tree rows. Appropriate herbicides can be applied in the row, or the areas can be rototilled or hoed by hand.

The moderate permeability of this soil is a limitation for septic tank absorption fields, but this can generally be overcome by increasing the size of the absorption field. Mounding of the septic tank absorption field on several feet of suitable fill material increases the filtering capacity of the soil. Sewage lagoons can be constructed on areas of this soil if, after excavation, the bottom of the lagoon is sealed to prevent seepage. This soil is generally suited to shallow excavations. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the

soil. Coarser grained material for subgrade or base material can be used to ensure better performance.

This Paka soil is in capability units IIe-3 dryland and IIe-5 irrigated. It is in the Sandy range site and windbreak suitability group 5.

PgC—Paka fine sandy loam, 2 to 6 percent slopes. This deep, gently sloping, well drained soil is on uplands. It is in areas that have loamy eolian material deposited over loamy and silty material weathered from siltstone. Individual areas range from 5 to 300 acres.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 8 inches thick. The subsoil is about 17 inches thick. It is brown, friable clay loam in the upper part; pale brown, friable silty clay loam in the middle part; and light gray, friable, calcareous silt loam in the lower part. The underlying material, about 16 inches thick, is white, calcareous silt loam. White, calcareous, weakly cemented siltstone is at a depth of about 41 inches. In places, the surface layer is loamy sand or loam. In places, the dark surface soil is more than 20 inches thick. In places, the subsoil is loam or sandy clay loam. In places, the lower part of the subsoil and the underlying material are loamy sand or fine sandy loam. In a few places, the siltstone is at a depth of 20 to 40 inches.

Included with this soil in mapping are small areas of Anselmo, Boelus, Brunswick, Dunday, and O'Neill soils. Anselmo, Boelus, Dunday, and O'Neill soils formed in coarser textured material and are generally in higher positions on the landscape. Brunswick soils are in similar positions and contain more sand. They have sandstone at a depth of 20 to 40 inches. Also included are small areas on ridgetops and knolls where the bedded siltstone or sandstone is exposed at the surface. Fragments are on the surface in places. Included soils make up 10 to 15 percent of this map unit.

Permeability of this Paka soil is moderate, and the available water capacity is high. The organic matter content is moderately low, and natural fertility is medium. The water intake rate is moderate. Runoff is medium. The soil is neutral to moderately alkaline. This soil has good tilth and is easily tilled.

Most of the acreage of this soil is in cultivated crops. The remaining acreage is in native grass and is used as rangeland.

Under dryland farming, this soil is suited to corn, small grains, soybeans, sorghum, and alfalfa. Soil blowing and water erosion are the main hazards. A cropping system that follows row crops with close-growing crops and that uses tillage operations that leave most of the crop residue on the surface helps to conserve moisture and control soil blowing. Terraces, contour farming, and stripcropping help to control water erosion. Returning crop residue to the soil and adding barnyard manure increase the organic matter content and natural fertility.

Under irrigation, this soil is suited to corn, sorghum, alfalfa, soybeans, and introduced grasses. Gravity irrigation systems using contour furrows or borders on the lesser slopes can be used. Sprinkler systems are best suited. Soil blowing is a hazard. Wheel track erosion can be a problem under center-pivot systems. Adjusting the water application rate to the water intake rate of the soil by good water management helps to control water erosion in the wheel tracks. Conservation tillage practices, such as discing or chiseling, and till-plant systems of planting keep all or most of the crop residue on the surface. This helps to control water erosion and soil blowing and improves the water intake rate. Installing terraces and farming on the contour help to control water erosion.

This soil is suited to rangeland. This use is effective in controlling soil blowing and water erosion. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. Proper grazing use, deferment from grazing, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. Inadequate moisture and severe soil blowing are the principal hazards in the establishment of trees. Trees need to be irrigated during prolonged dry periods. The trees can be planted on the contour to help prevent water erosion. Soil blowing can be prevented by maintaining strips of sod or other vegetation between the rows. Weeds and undesirable grasses can be controlled by cultivating with conventional equipment or by use of appropriate herbicides. Areas next to the tree can be rototilled or hoed by hand.

The moderate permeability of this soil is a limitation for septic tank absorption fields, but this can be overcome by increasing the size of the absorption field. Mounding of the septic tank absorption field on several feet of suitable fill material increases the filtering capacity of the soil. Sewage lagoons can be constructed on areas of this soil if, after excavation, the bottom of the lagoon is sealed to prevent seepage. Grading is required to modify the slope and shape the lagoon. This soil is generally suited to shallow excavations. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Small commercial buildings may need to be designed to accommodate the slope, or the soil can be graded to an acceptable gradient. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarser grained material for subgrade or base material can be used to ensure better performance.

This Paka soil is in capability units IIIe-3 dryland and IIIe-5 irrigated. It is in the Sandy range site and windbreak suitability group 5.

Ph—Paka loam, 0 to 2 percent slopes. This deep, well drained, nearly level soil is on uplands. Individual areas range from 5 to 100 acres.

Typically, the surface layer is dark grayish brown, very friable loam about 7 inches thick. The subsurface layer is dark grayish brown, very friable silt loam about 5 inches thick. The subsoil is about 22 inches thick. The upper part is brown, friable silty clay loam; the middle part is pale brown, very friable silt loam; and the lower part is very pale brown, very friable silt loam. The underlying material, about 20 inches thick, is very pale brown, calcareous silt loam. White, calcareous siltstone is at a depth of 54 inches. In places, the dark surface soil is more than 20 inches thick. In a few places, the surface layer is fine sandy loam. In places, the subsoil is loam or sandy clay loam. In places, the profile lacks free carbonates.

Included with this soil in mapping are small areas of Anselmo, Jansen, and O'Neill soils. Anselmo soils are higher on the landscape and are coarser textured. Jansen and O'Neill soils are in similar positions and have gravelly coarse sand at a depth of 20 to 40 inches. Included soils make up 10 to 15 percent of this map unit.

Permeability of this Paka soil is moderate, and the available water capacity is high. The organic matter content is moderate, and natural fertility is medium. The water intake rate is moderately low. The soil is neutral to moderately alkaline. Runoff is slow. Tilth is generally good, and this soil is easily tilled.

Most of the acreage of this soil is used as cropland. Much of it is irrigated. The remaining areas are in native grass and are used as rangeland.

Under dryland farming, this soil is suited to corn, alfalfa, sorghum, small grains, and soybeans. Conserving soil moisture is the main problem. Inadequate seasonal rainfall limits crop and grass production in most years. Using a cropping system that keeps the soil covered with crops or crop residue helps to maintain soil moisture and control soil blowing. Adding barnyard manure increases the organic matter content and fertility.

Under irrigation, this soil is suited to corn, alfalfa, sorghum, soybeans, and introduced grasses. Conservation tillage practices, such as discing or chiseling, keep all or part of the crop residue at the surface. For row crops, use of till-plant or no-till planting methods keeps crop residue on the surface. Adding barnyard manure to the soil improves the organic matter content and increases the water intake rate.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. All trees and shrubs that are moderately drought-tolerant are suited. Irrigation can provide supplemental moisture during periods of low rainfall. Competition for moisture from weeds and undesirable grasses is a problem. Weeds and undesirable grasses can be controlled by cultivating between the rows with conventional equipment. Appropriate herbicides can be applied in the tree row, or the areas can be hoed by hand or rototilled.

The moderate permeability of this soil is a limitation for septic tank absorption fields, but this can generally be overcome by increasing the size of the absorption field. Mounding of the septic tank absorption field on several feet of suitable fill material increases the filtering capacity of the soil. Sewage lagoons can be constructed on areas of this soil if, after excavation, the bottom of the lagoon is sealed to prevent seepage. This soil is generally suited to shallow excavations. Foundations for buildings need to be strengthened and backfilled with coarser material to prevent damage by the shrinking and swelling of the soil. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarser grained material for subgrade or base material can be used to ensure better performance.

This Paka soil is in capability units IIc-1 dryland and I-4 irrigated. It is in the Silty range site and windbreak suitability group 3.

PhC—Paka loam, 2 to 6 percent slopes. This deep, gently sloping, well drained soil is on uplands. It is on plane and slightly convex side slopes. Individual areas range from 5 to 300 acres.

Typically, the surface layer is dark grayish brown, very friable loam about 9 inches thick. The subsoil is about 17 inches thick. The upper part is grayish brown, very friable silty clay loam; the middle part is brown, very friable silt loam; and the lower part is pale brown, very friable silt loam. The underlying material, about 18 inches thick, is very pale brown, calcareous silt loam. White, calcareous, weakly cemented siltstone is at a depth of about 44 inches. In places, the surface layer is silty clay loam, silt loam, or fine sandy loam. In eroded areas, the grayish brown subsoil material is at the surface. In places, carbonates are near the surface, and, in places, the profile is noncalcareous. In places, the subsoil is loam or sandy clay loam. In places, bedrock is at a depth of 20 and 40 inches.

Included with this soil in mapping are small areas of Anselmo, Brunswick, Jansen, and O'Neill soils. Anselmo and Brunswick soils are in similar positions and are coarser textured. Jansen and O'Neill soils are higher on the landscape and have gravelly coarse sand at a depth of 20 to 40 inches. Included soils make up 10 to 15 percent of this map unit.

Permeability of this Paka soil is moderate, and the available water capacity is high. The organic matter content is moderate, and natural fertility is medium. The

soil is neutral to moderately alkaline. Runoff is medium. The water intake rate is moderately low. This soil is easy to work and keep in good tilth.

Most of the acreage of this soil is used as cropland under dryland and irrigation management. Areas that remain in native grass are used as rangeland.

Under dryland farming, this soil is suited to corn, sorghum, alfalfa, soybeans, and small grains. Water erosion and soil blowing are hazards. Installing terraces and farming on the contour or stripcropping reduce water erosion. Keeping the soil covered with crops or crop residue reduces erosion and helps to conserve soil moisture. Adding barnyard manure to the soil increases the organic matter content and improves fertility.

Under irrigation, this soil is suited to corn, soybeans, alfalfa, sorghum, and introduced grasses. Gravity and sprinkler irrigation systems are suited to this soil. Slopes need to be reduced by land leveling for gravity irrigation. Under center-pivot irrigation systems, water erosion can be a problem in the wheel tracks. Proper irrigation water management is needed to be sure that water is applied at a rate slow enough to prevent runoff. Terraces can be installed to control water erosion. Contour farming, stripcropping, and tillage practices that leave the crop residue at the surface reduce erosion and conserve soil moisture. Adding barnyard manure increases the organic matter content and fertility and improves the water intake rate of the soil.

This soil is suited to rangeland. This use is effective in controlling water erosion and soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve the range condition and keep the soil in good condition.

This soil is suited to trees and shrubs planted in windbreaks. Trees can be planted on the contour in combination with terraces to allow normal cultivation between the rows in order to store moisture and to control weeds. Irrigation can provide supplemental moisture during periods of low rainfall. Competition from weeds and undesirable grasses can be controlled by cultivation with conventional equipment and by the use of appropriate herbicides.

The moderate permeability of this soil is a limitation for septic tank absorption fields, but this can be overcome by increasing the size of the absorption field. Mounding of the septic tank absorption field on several feet of suitable fill material increases the filtering capacity of the soil. Sewage lagoons can be constructed on areas of this soil if, after excavation, the bottom of the lagoon is sealed to prevent seepage. Grading is required to modify the slope and shape the lagoon. This soil is generally suited to shallow excavations. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Small commercial buildings need to be designed to accommodate the slope, or the soil can be graded to an acceptable gradient. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil material. Coarse grained material for subgrade or base material can be used to ensure better performance.

This Paka soil is in capability units IIIe-1 dryland and IIIe-4 irrigated. It is in the Silty range site and windbreak suitability group 3.

PhD2—Paka loam, 6 to 11 percent slopes, eroded. This deep, strongly sloping, well drained soil is on uplands. Erosion has reduced the surface layer to a thickness of about 6 inches. In places, tillage has mixed the upper part of the subsoil with the remaining surface layer. Individual areas range from 5 to 200 acres.

Typically, the surface layer is brown, very friable loam about 6 inches thick. The subsoil is about 14 inches thick. The upper part of the subsoil is pale brown, friable light silty clay loam, and the lower part is light gray, friable, calcareous silt loam. The underlying material to a depth of about 42 inches is white, calcareous silt loam. Very pale brown, calcareous siltstone is at a depth of about 42 inches. In places, the surface layer is silty clay loam, silt loam, or fine sandy loam. In places, carbonates are at the surface. Some profiles are noncalcareous. In places, the subsoil is loam or sandy clay loam. In places, bedrock is at a depth of 20 to 40 inches. In severely eroded areas, the lower part of the subsoil or the underlying material is exposed.

Included with this soil in mapping are small areas of Anselmo, Brunswick, Jansen, and O'Neill soils. Anselmo and Brunswick soils are in similar positions on the landscape as the Paka soil and are coarser textured. Jansen and O'Neill soils have sand and gravel at a depth of 20 to 40 inches. These soils are normally above the Paka soil on the landscape. Included soils make up 10 to 15 percent of this map unit.

Permeability of this Paka soil is moderate. The available water capacity is high. Organic matter content and natural fertility are low. The soil is neutral to moderately alkaline. The water intake rate is moderate. Runoff is medium or rapid. This soil is easy to work, but generally it does not have good tilth. The soil puddles if worked when wet.

About half of the acreage of this soil is in cropland, and much of it is irrigated. The rest of the acreage is in native grass and is used as rangeland.

Under dryland farming, this soil is poorly suited to corn, sorghum, and soybeans. It is better suited to alfalfa, introduced grasses, and small grains. Water erosion is a hazard. Terraces, contour farming, and grassed waterways can be used on smooth slopes to reduce runoff and control erosion. On irregular slopes, close-growing crops and tillage practices that leave the

crop residue at the surface help to control erosion. Row crops need to be limited in the cropping sequence in order to reduce soil loss by erosion. Using crop residue as mulch during tillage and seedbed preparation helps to control water erosion and conserve soil moisture. Adding barnyard manure increases the organic matter content and improves fertility.

Under irrigation, this soil is poorly suited to corn, sorghum, and soybeans. It is better suited to alfalfa and introduced grasses. Only sprinkler irrigation systems are suited to this soil because of the steepness of slopes. Water erosion is the main hazard. If center-pivot irrigation systems are used, water erosion can be a serious problem in the wheel tracks. Terraces, contour farming, and grassed waterways are needed to reduce runoff and control erosion. Keeping the soil covered with crops or crop residue helps to control erosion. Adding barnyard manure to the soil increases the organic matter content and the water intake rate.

This soil is suited to rangeland. This use is effective in controlling water erosion and soil blowing. Overgrazing by livestock or improper timing of haying reduces the protective cover, causes deterioration of the native plants, and causes severe soil losses by water erosion. Proper grazing use, timely deferments from grazing or haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. Drought and competition for moisture from weeds and undesirable grasses are the main problems. Water erosion is a hazard. Planting trees on the contour in combination with terraces allows normal cultivation between the rows to store moisture and control weeds. Irrigation can provide supplemental moisture during periods of insufficient rainfall. Cultivation between the rows with conventional equipment controls undesirable grasses and weeds. Careful use of appropriate herbicides or cultivating by hand can control weeds in the row.

Land shaping and installing the septic tank absorption field on the contour are generally necessary for proper operation. The moderate permeability of this soil is a limitation for septic tank absorption fields, but this can generally be overcome by increasing the size of the absorption field. The mounding of septic tank asorption fields on several feet of suitable fill material increases the filtering capacity of the soil. For sewage lagoons, grading is required to modify the slope and shape the lagoon. The slope increases the difficulty of digging in this soil. Dwellings and small commercial buildings need to be properly designed to accommodate the slope, or the soil can be graded to an acceptable gradient. Foundations for buildings need to be strengthened and backfilled with coarser material to prevent damage by the shrinking and swelling of the soil. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarser grained material for subgrade or base material can be used to ensure better performance.

This Paka soil is in capability units IVe-1 dryland and IVe-4 irrigated. It is in the Silty range site and windbreak suitability group 3.

Pm—Pits, sand and gravel. This map unit consists mostly of areas from which sand and gravel are removed for commercial uses and for roads. It includes the piles and ridges of waste sand and gravel that border the pits. Some pits are filled with water. Areas range from 5 to 150 acres.

In most of these areas, gravel is being pumped from water-filled pits, and the areas are subject to constant changes in shape and size. A few small areas are dry pits where sand and gravel is removed by methods other than pumping. Also included are old pits that are no longer being used.

Abandoned pit areas are not suitable for cultivation and have little value for range unless vegetation is reestablished. Some of these areas can be developed for recreation, especially fishing, and some provide limited cover for wildlife. Planting native grass and trees on these areas helps to control soil blowing. Species selected should be suited to the sandy, droughty conditions and low fertility.

Most of the gravel pits are privately owned and operated. Sand and gravel extracted from these pits are used mostly for roads and building material.

This map unit is in capability unit VIIIs-1 dryland and windbreak suitability group 10. It is not assigned to a range site.

PtB—Pivot loamy sand, 0 to 3 percent slopes. This nearly level to very gently sloping, somewhat excessively drained soil is on uplands and stream terraces. It is moderately deep over gravelly coarse sand. Individual areas range from 5 to several thousand acres.

Typically, the surface layer is dark gray, very friable loamy sand about 6 inches thick. The subsurface layer is dark grayish brown, very friable loamy sand about 10 inches thick. The transitional layer is grayish brown, very friable loamy sand about 5 inches thick. The underlying material is brown coarse sand in the upper part and pale brown, gravelly coarse sand in the lower part. It extends to a depth of more than 60 inches. In places, the surface layer is fine sand or sand. This soil is dark to a depth of less than 10 inches on some of the eroded ridges and knolls. In places, a thin strata of loamy material is above the gravelly coarse sand. In places, the underlying material is fine sand or sand.

Included with this soil in mapping are small areas of Boelus, Dunday, Dunn, Meadin, and O'Neill soils. Boelus, Dunday, and Dunn soils are in slightly higher positions on the landscape. Boelus and Dunn soils have loamy underlying material. Dunday soils are sandy throughout.

Meadin soils are lower on the landscape and have gravelly coarse sand closer to the surface. O'Neill soils are in similar positions on the landscape, but they have finer texture above the gravelly coarse sand. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Pivot soil is rapid in the upper part and very rapid in the gravelly coarse sand. The available water capacity is low. Natural fertility is medium, and the organic matter content is moderately low. The soil is medium acid to neutral. Runoff is very slow because the water intake rate is very high. This soil is easily tilled throughout a wide range of moisture content.

Areas of this soil are used mostly for irrigated cropland and native grass. The native grass areas are used mostly for grazing, but a small acreage is harvested for hay.

Under dryland farming, this soil is poorly suited to corn, sorghum, alfalfa, and small grains. Soil blowing is a hazard where the surface is not adequately protected by growing crops or crop residue. Conserving soil moisture is a problem. Soil blowing can be reduced, moisture conserved, and the organic matter content and fertility maintained by using a cropping system that keeps the soil covered with crops, crop residue, or grass. Row crops need to be limited in the cropping sequence, and maximum use needs to be made of close-growing crops that protect the soil. The low available water capacity makes this soil quite droughty.

Under irrigation, this soil is suited to corn, sorghum, alfalfa, small grains, and introduced grasses. Sprinkler irrigation is the only method suited to this soil. Frequent, light applications of water are needed because of the low available water capacity and to avoid excessive leaching. This soil is too sandy for gravity irrigation. Soil blowing is a hazard on this soil. Tillage practices that keep crops or crop residue on the surface help to control soil blowing and conserve moisture. Crop residue should be left on the surface in winter to reduce soil blowing. Returning crop residue to the soil and using barnyard manure help to increase the organic matter content and fertility.

This soil is suited to rangeland, either for grazing or haying. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition. Some areas need to be reseeded.

A few areas in native grass are mowed for hay. The grass should be mowed only about once in two years. If mowed one summer, it should not be grazed the next summer. It can be safely grazed in fall or winter if the areas are stocked properly.

This soil is suited to trees and shrubs planted in windbreaks if soil blowing is controlled by maintaining strips of sod or other vegetation between the rows. Drought and competition for moisture from grasses and weeds are hazards. Trees and shrubs need to be watered during periods of low rainfall. Weeds and undesirable grasses in the tree rows can be controlled by cultivation and by timely use of herbicides. Areas near the trees can be rototilled or hoed by hand.

This soil is generally suited to building sites and local roads and streets. If this soil is used for septic tank absorption fields, care should be taken so that pollution by seepage does not contaminate nearby water supplies. The soil readily absorbs effluent from absorption fields, but it does not adequately filter the effluent. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

This Pivot soil is in capability units IVe-5 dryland and IIIe-14 irrigated. It is in the Sandy range site and windbreak suitability group 5.

PtC—Pivot loamy sand, 3 to 9 percent slopes. This gently sloping to strongly sloping, somewhat excessively drained soil is on uplands and stream terraces. It is moderately deep over gravelly coarse sand. Individual areas range from 5 to 2,000 acres.

Typically, the surface layer is dark grayish brown, very friable loamy sand about 7 inches thick. The subsurface layer is grayish brown, very friable loamy sand about 5 inches thick. The transitional layer is brown, loose sand about 9 inches thick. The underlying material is light yellowish brown, coarse sand in the upper part and gravelly coarse sand in the lower part. It extends to a depth of 60 inches or more. In places, this soil is dark to a depth of less than 10 inches. In places, thin strata of loamy material are above the gravelly coarse sand. In places, the underlying material is fine sand or sand.

Included with this soil in mapping are small areas of Boelus, Dunday, Meadin, O'Neill, and Simeon soils. These soils are in similar positions on the landscape. Boelus soils have loamy underlying material. Dunday and Simeon soils are sandy throughout. O'Neill soils have finer texture. Meadin soils have gravelly coarse sand at a depth of 8 to 20 inches. Included soils make up 10 to 15 percent of this map unit.

Permeability of this Pivot soil is rapid in the upper part and very rapid in the underlying material. The available water capacity is low. Natural fertility is medium, and the organic matter content is moderately low. The water intake rate is very high, and runoff is slow. The soil is medium acid to neutral.

Most areas of this soil are in native grass and are used as rangeland. Areas that are used as cropland are irrigated.

Under dryland farming, this soil is unsuited to cultivated crops because of droughtiness and the hazards of soil blowing and water erosion.

Under irrigation, this soil is poorly suited to corn, small grains, and alfalfa. Where slopes exceed 6 percent, small grains and alfalfa are best suited. Sprinkler irrigation is the only system suited to this soil. Water needs to be applied lightly and frequently to avoid leaching the plant nutrients below the root zone. This soil is too sandy for gravity irrigation. Keeping the soils covered with crops or crop residue controls soil blowing. Farming on the contour, stripcropping, and stubble mulch tillage help to control water erosion. To obtain maximum crop residue cover, removal of the crop residue should be limited, and grazing of the residue should be restricted. Returning crop residue to the soil increases the organic matter content and improves fertility. Adding barnyard manure improves fertility and increases the water intake rate.

This soil is suited to rangeland. This use is very effective in controlling soil blowing and water erosion. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. Inadequate moisture, competition from undesirable grasses and weeds, and soil blowing are the main problems. Irrigation can provide supplemental water during periods of low rainfall. Weeds and grass in the tree row can be controlled by timely use of herbicides and by cultivating with conventional equipment or hoeing by hand. Soil blowing can be controlled by maintaining strips of sod or cover crops between the rows of trees. Trees can be planted on the contour to help prevent erosion.

This soil is generally suited to use as sites for dwellings and local roads and streets. This soil readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent. The poor filtering capacity can result in pollution of the underground water table. Sewage lagoons need to be lined and sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Small commercial buildings may need to be properly designed to accommodate the slope, or the soil can be graded to an acceptable gradient.

This Pivot soil is in capability units VIe-5 dryland and IVe-14 irrigated. It is in the Sandy range site and windbreak suitability group 5.

Rw—Riverwash. This map unit consists of alluvial material deposited as sandbars, sand flats, and islands mostly within and adjacent to channels of the Elkhorn and Niobrara Rivers and some of the larger creeks. It is very poorly drained and frequently flooded. Individual areas range from 5 to 20 acres.

This map unit consists mostly of stratified sand and gravel. The surface is 6 inches to about 3 feet above the level of normal streamflow. Flooding, reworking, and shifting of the material is common during periods of high streamflow. Most areas have very little vegetation or no vegetation because the soil material is too coarse textured and droughty. A few areas have been in place long enough for willows, reeds, and some brushy plants to grow. The size and shape of most areas change with each flood.

Riverwash has little or no agricultural value and is used for whatever grazing is available. It is used mostly by wildlife.

This map unit is in capability unit VIIIw-7 and windbreak suitability group 10. It is not assigned to a range site.

SaG—Sansarc silty clay, 20 to 40 percent slopes. This well drained soil is on uplands. It is on steep and very steep, narrow, convex ridges; sharp slope breaks; and upper sides of some drainageways. It is shallow over dark shale. Individual areas range from 20 to 500 acres.

Typically, the surface layer is firm, grayish brown, calcareous silty clay about 4 inches thick. The underlying material, about 5 inches thick, is brown and light olive brown, calcareous shaly clay. Light brownish gray and light yellowish brown, calcareous, bedded shale is at a depth of about 9 inches.

Included with this soil in mapping are small areas of Bristow, Labu, Simeon, and Valentine soils. Bristow soils are lower on the landscape and formed in light colored shale. Labu soils occupy the broader, convex ridgetops and lower side slopes where the depth to shale is more than 20 inches. Simeon and Valentine soils are higher on the landscape and are sandy throughout the profile. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Sansarc soil is slow. The available water capacity is very low. The organic matter content is moderately low, and natural fertility is low. The soil is neutral to moderately alkaline. Runoff is very rapid.

Areas of this soil are in native grass and are used as rangeland.

This soil is suited to rangeland. This use is effective in controlling water erosion. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. Gullies form quickly if the native vegetation is destroyed. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve the range condition.

This soil is unsuited to trees and shrubs planted in windbreaks because of the steep slopes. Some areas can be used for recreational, wildlife, and forestation plantings of tolerant trees or shrubs if they are planted by hand or other approved special practices are used.

This soil generally is not suited to sanitary facilities because of the steep and very steep slopes and shallow

depth to bedrock. A suitable alternate site is needed. Roads need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarser grained material for subgrade or base material can be used to ensure better performance. Cuts and fills are generally needed to provide a suitable grade for roads. The base material for roads and streets can be mixed with additives, such as hydrated lime, to help prevent shrinking and swelling.

This Sansarc soil is in capability unit VIIe-4 dryland. It is in the Shallow Clay range site and windbreak suitability group 10.

SkB—Simeon sand, 0 to 3 percent slopes. This deep, nearly level to very gently sloping, excessively drained soil is on uplands. Individual areas range from 40 to 1,000 acres or more.

Typically, the surface layer is grayish brown, loose sand about 5 inches thick. The transitional layer is brown, loose sand about 5 inches thick. The underlying material is pale brown sand in the upper part, very pale brown sand in the middle part, and light gray sand in the lower part. It extends to a depth of more than 60 inches. Fine gravel is scattered throughout the profile. In a few places, the underlying material is coarse sand. Thin layers of gravelly coarse sand are in the underlying material in a few places.

Included with this soil in mapping are small areas of Meadin, Pivot, and Valentine soils. Meadin and Pivot soils are in similar positions on the landscape and contain more gravel in the underlying material. Valentine soils are usually on the higher ridges and dunes and contain finer sand. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Simeon soil is rapid, and the available water capacity is low. The organic matter content and natural fertility are low. The soil is slightly acid or neutral. Runoff is slow.

Almost all of this soil is in native rangeland. A few small areas are used as irrigated cropland.

Under dryland farming, this soil is unsuited to crops because it is too droughty and subject to soil blowing.

Under irrigation, this soil is poorly suited to corn, soybeans, alfalfa, introduced grasses, and small grains. Only the sprinkler method of irrigation is suitable on this soil. The soil is too sandy for gravity irrigation. Frequent applications of water are needed to avoid leaching nutrients below the plant roots. The center-pivot system of sprinkler irrigation is particularly well suited. Introduced grasses and small grains are the most suitable irrigated crops, but corn, soybeans, and alfalfa can be grown. Soil blowing is a severe hazard. Maintaining a high amount of crop residue on the surface at all times and keeping tillage to a minimum control soil blowing. Adding barnyard manure increases the organic matter content and improves soil fertility.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. It also can cause severe losses by soil blowing and create small blowouts. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve the range condition.

This soil generally is unsuited to trees and shrubs planted in windbreaks because it is very droughty, and soil blowing is a severe hazard. Some areas can be used for recreation, forestation, and wildlife plantings of tolerant trees and shrubs if approved special practices are used.

This soil is generally suited to use as building sites and for local roads and streets. Where this soil is used for septic tank absorption fields, care should be taken so that pollution by seepage does not contaminate nearby water supplies. The soil readily absorbs effluent from absorption fields, but it does not adequately filter the effluent. Sewage lagoons need to be lined and sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

This Simeon soil is in capability units VIe-4 dryland and IVs-14 irrigated. It is in the Shallow to Gravel range site and windbreak suitability group 10.

SmB—Simeon loamy sand, 0 to 3 percent slopes. This deep, nearly level to gently sloping, excessively drained soil is on sandy uplands and stream terraces. Individual areas range from about 5 to 1,000 acres or more.

Typically, the surface layer is grayish brown, very friable loamy sand about 8 inches thick. The transitional layer is brown, loose sand about 10 inches thick. The underlying material is light yellowish brown coarse sand in the upper part and very pale brown sand in the lower part. It extends to a depth of more than 60 inches and contains up to 5 percent gravel. In a few places, the underlying material is fine sand below a depth of 40 inches. In places, the underlying material contains strata of gravelly coarse sand.

Included with this soil in mapping are small areas of Dunday, Meadin, Pivot, and Valentine soils. Dunday, Meadin, and Pivot soils are in similar positions on the landscape. Dunday soils have fine sand underlying material. Meadin and Pivot soils have gravelly coarse sand underlying material. Valentine soils are on higher positions and contain finer sand. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Simeon soil is rapid, and the available water capacity is low. The organic matter content and natural fertility are low. The soil is slightly acid or neutral. Surface runoff is very slow, and the water intake rate is very high. This soil is easily tilled throughout a wide range in moisture content.

Most areas of this soil are in native grass and are used as rangeland. A few areas are used as irrigated cropland.

Under dryland farming, this soil is unsuited to crops because it is too droughty and easily eroded by wind.

Under irrigation, this soil is poorly suited to introduced grasses, corn, soybeans, and alfalfa. Sprinkler irrigation is the only suitable method for this soil. It is too sandy for gravity irrigation. Frequent, light applications of water are needed to avoid leaching nutrients below the root zone. Soil blowing and maintenance of productivity are the principal management concerns. Maintaining a high amount of crop residue on the surface and keeping tillage to a minimum help to control soil blowing. Adding barnyard manure increases the organic matter content and improves fertility. All crop residue should be returned to the soil.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition.

This soil generally is unsuited to trees and shrubs planted in windbreaks because it is very droughty, and severe soil blowing is a hazard. Some areas can be used for recreational, forestation, and wildlife plantings of tolerant trees and shrubs if special approved practices are used.

This soil is generally suited to use as building sites and for local roads and streets. Where this soil is used for septic tank absorption fields, care should be taken so that pollution by seepage does not contaminate nearby water supplies. This soil readily absorbs effluent from absorption fields, but it does not adequately filter it. Sewage lagoons need to be lined and sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

This Simeon soil is in capability units VIs-4 dryland and IVs-14 irrigated. It is in the Shallow to Gravel range site and windbreak suitability group 10.

Te—Trent silt loam, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is on flats and in swales on the uplands. Individual areas range from 5 to 1,500 acres.

Typically, the surface layer is dark grayish brown, very friable silt loam about 6 inches thick. The subsurface layer is similar to the surface layer in color and texture and is about 5 inches thick. The subsoil is about 29 inches thick. It is dark grayish brown, friable silt loam in the upper part and brown, friable silty clay loam in the lower part. The underlying material is pale brown silty clay loam to a depth of more than 60 inches. In places, the surface layer is silty clay loam, loam, or fine sandy loam. The subsoil in places is silt loam. In places, sandy underlying material is below a depth of 40 inches. In places, this soil is dark to a depth of less than 20 inches.

Included with this soil in mapping are small areas of Bazile, Fillmore, and Jansen soils. Bazile and Jansen soils are on slightly higher positions. Bazile soils have sand at a depth of 20 to 40 inches. Jansen soils have gravelly coarse sand at a depth of 20 to 40 inches. Fillmore soils are in depressions and contain more clay. Fillmore soils are also poorly drained. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Trent soil is moderate. The available water capacity is high. The organic matter content is moderate, and natural fertility is high. The soil ranges from medium acid to neutral. The water intake rate for irrigation is moderately low. Runoff is slow, and some areas receive runoff from adjacent areas during heavy rains. Tilth is generally good, and this soil is easily tilled.

Most of the acreage of this soil is cultivated. A few small areas are in native grass and are used as pasture or hayland.

Under dryland farming, this soil is suited to small grains, soybeans, sorghum, corn, alfalfa, and introduced grasses. Conservation tillage practices that leave crop residue on the soil surface help to prevent soil blowing and conserve soil moisture. Returning crop residue and barnyard manure to the soil helps to maintain and improve the organic matter content and natural fertility and increases the water intake rate.

Under irrigation, this soil is suited to corn, sorghum, soybeans, alfalfa, and introduced grasses. Sprinkler and gravity irrigation systems are suited to this soil. Land leveling is generally needed for gravity irrigation to achieve even distribution of water. Keeping crop residue on the soil surface helps to reduce soil blowing. Crop residue and barnyard manure help to improve the water intake rate and tilth.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain and improve the range condition.

This soil is suited to trees and shrubs planted in windbreaks. Inadequate rainfall is the principal limitation for planting trees, and irrigation of the seedlings may be needed. Competing vegetation can be controlled by using good site preparation, timely cultivation, and application of herbicides.

The moderate permeability of this soil is a limitation for septic tank absorption fields, but this generally can be overcome by increasing the size of the absorption field. Sewage lagoons need to be lined or sealed to prevent seepage. This soil is generally suited to shallow excavations. Foundations for buildings need to be strengthened and backfilled with coarse material to

prevent damage by the shrinking and swelling of the soil. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarser grained material for subgrade or base material can be used to ensure better performance. Damage to roads and streets by frost action can be reduced by providing good surface drainage. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This Trent soil is in capability units IIc-1 dryland and I-4 irrigated. It is in the Silty range site and windbreak suitability group 3.

To—Tryon loamy fine sand, 0 to 2 percent slopes. This deep, nearly level, poorly drained soil is in valleys in sandhill areas. It is rarely flooded. Individual areas range from 5 to 1,000 acres or more.

Typically, the surface layer is mottled, dark gray, very friable loamy fine sand about 4 inches thick. The subsurface layer is similar to the surface layer in color and texture and is about 4 inches thick. The next layer is mottled, pale brown, loose fine sand about 6 inches thick. Below this is a buried surface layer that is mottled, gray, loose loamy sand about 6 inches thick. The underlying material to a depth of 60 inches is mottled fine sand that is light gray in the upper part, gray in the middle part, and light brownish gray in the lower part. In a few places, the surface layer is fine sandy loam. A thin layer of fine sand is commonly on the surface where this soil is adjacent to large areas of sandhills. In places, the surface layer is more than 10 inches thick. Water ponds on the surface in some of the low areas and drainageways for a few days in the spring and during wet periods.

Included with this soil in mapping are small areas of Els and Marlake soils. Els soils are slightly higher on the landscape and are somewhat poorly drained. Marlake soils are lower on the landscape and have a higher seasonal water table. Some areas near the edges of a mapped area are severely affected with alkali. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Tryon soil is rapid, and the available water capacity is low. Natural fertility is low, and the organic matter content is high. The soil is slightly acid to moderately alkaline. Runoff is very slow. The seasonal high water table ranges from at the surface in wet years to a depth of about 1.5 feet in dry years. The water table normally recedes to a depth of about 2 to 3 feet late in summer.

Most of the acreage of this soil is in rangeland and is either grazed or used as hayland.

This soil is too wet for use as cropland.

This soil is suited to rangeland, either for grazing or haying. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the vegetative cover and cause deterioration of the native plants. If the soil is wet, overgrazing can cause compaction and small mounds, making it difficult to graze or harvest for hay. Proper grazing use, timely deferment from grazing, and restricted use during wet periods help to maintain the native plants in good condition.

Where the soil is used for hayland, mowing needs to be regulated so that the grasses remain vigorous and keep their place in the meadow. In order to allow for carbohydrate storage in plants in meadows, mowing needs to be avoided between boot stage and seed maturity. Large areas can be divided into three parts and mowed in rotation. One-third should be mowed about two weeks before plants reach the boot stage, one-third at boot stage, and one-third in the early flowering period. The areas should be rotated in successive years. If a rancher has plenty of hay, the entire area can be left idle one year in three, particularly if the rotation mowing plan is not followed. Hay production can be increased by proper fertilization with nitrogen and phosphate. After frost and during winter, range animals can usually graze meadows without damage if the areas are not overstocked. Livestock need to be removed before the frost leaves the soil and the water table reaches a high level.

This soil is poorly suited to trees and shrubs planted in windbreaks. Wetness from the high water table is the main limitation. Only trees and shrubs that are tolerant of a high water table are suited to this soil. Preparation of the soil and planting of trees in the spring may not be possible until the water table recedes and the soil is sufficiently dry. Weeds and undesirable grasses that compete with the trees can be controlled by cultivating between the rows when the water table is lowest or by using appropriate herbicides. Areas close to trees can be rototilled or hoed by hand.

This soil is not suited to septic tank absorption fields and dwellings because of wetness. A suitable alternate site is needed. Sewage lagoons need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal high water table. Sewage lagoons need to be lined and sealed to prevent seepage. Constructing roads and streets on suitable, well compacted fill material and providing adequate side ditches and culverts help to protect roads from wetness.

This Tryon soil is in capability unit Vw-7 dryland. It is in the Wet Subirrigated range site and windbreak suitability group 2D.

Tp—Tryon loamy fine sand, wet, 0 to 2 percent slopes. This soil is deep, nearly level, and very poorly drained. It occurs on valley floors in sandhill areas and on bottom lands along some of the major streams that drain from the sandhills. This soil is rarely flooded, but it is occasionally ponded by water from a very high water table in the spring and during wet periods. Individual areas range from 5 to 200 acres.

Typically, the surface layer is dark gray, very friable loamy fine sand about 5 inches thick. The transitional layer is grayish brown, loose fine sand about 3 inches thick. The underlying material is light gray fine sand to a depth of more than 60 inches. It has yellowish brown mottles. In places, the surface layer is fine sand or fine sandy loam. In places, the dark surface layer is more than 10 inches thick.

Included with this soil in mapping are small areas of Els and Marlake soils. Els soils are on slightly higher positions and are somewhat poorly drained. The Marlake soils are lower on the landscape and are wet for longer periods. A narrow band of alkali is at the outer edges of many areas of this soil. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Tryon soil is rapid, and the available water capacity is low. Natural fertility is low, and the organic matter content is high. The soil is slightly acid through moderately alkaline. Runoff is very slow. The seasonal high water table ranges from about 0.5 foot above the surface in wet years to a depth of about 1 foot in dry years. This soil can be ponded for a week or more at a time during wet periods. The water table normally recedes to a depth of about 1 foot to 2 feet by late in summer.

Most of the acreage of this soil is in rangeland and is grazed or harvested for hay.

This soil is too wet for cultivation.

This soil is suited to rangeland. Overgrazing, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. If the soil is wet, overgrazing causes compaction and small mounds, making it difficult to graze or harvest for hay. Proper grazing use, timely deferment from grazing or haying, and restricted use during very wet periods help to maintain the native plants in good condition.

Mowing needs to be regulated so that the grasses remain vigorous in areas where the soil is used for hayland. The high water table has drowned out most of the bluestem, switchgrass, and indiangrass. In some years, forage cannot be harvested because of wetness. Some hay meadows can be improved by installing V-ditches to hasten surface drainage and by seeding reed canarygrass into the existing vegetation. A proper mowing sequence should be followed. The meadow should be mowed before the dominant grasses reach the boot stage. Mowing should be avoided between boot stage and seed maturity. After frost and during winter, livestock can graze the meadows without damage if the areas are properly stocked. Range animals need to be removed before the frost leaves the soil and the water table reaches a high level.

This soil is unsuited to windbreak plantings of trees and shrubs because of wetness caused by the high water table. A few areas can be used for recreational, wildlife, or forestation plantings of tolerant trees or shrubs if they are planted by hand or other approved special practices are used.

This soil is not suited to septic tank absorption fields and dwellings because of wetness and ponding. A suitable alternate site is needed. Sewage lagoons need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal high water table and ponding level. Sewage lagoons need to be lined and sealed to prevent seepage and diked as protection from ponding or flooding. Constructing roads and streets on suitable, well compacted fill material above the ponding level and providing adequate side ditches and culverts help to protect roads from damage by ponding and wetness from the seasonal high water table.

This Tryon soil is in capability unit Vw-7. It is in the Wetland range site and windbreak suitability group 10.

Ts—Tryon-Inavale complex, channeled. This map unit consists of deep, poorly drained Tryon soil and deep, somewhat excessively drained Inavale soil. These soils are on bottom lands dissected by stream channels that meander across the flood plain (fig. 16). Slopes range from 0 to 2 percent. Areas of Tryon soil are subject to frequent flooding, but areas of the higher lying Inavale soil are rarely flooded. Floodwaters remain on the surface for only a short period. The complex is about 40 to 65 percent Tryon soil and 15 to 40 percent Inavale soil. Areas normally are long and narrow and range from 20 to 1,000 acres or more.

Typically, the Tryon soil has a surface layer of dark gray, very friable loamy fine sand about 5 inches thick. The transitional layer is grayish brown, loose fine sand about 4 inches thick. The underlying material is light gray fine sand with yellowish brown mottles to a depth of about 60 inches. In a few places, the surface layer is fine sandy loam or loam. In a few places, the underlying material is stratified with layers of coarse sand or gravelly coarse sand. In places, the dark surface soil is more than 10 inches thick.

Typically, the Inavale soil has a surface layer of grayish brown, loose fine sand about 8 inches thick. The transitional layer is light brownish gray, loose fine sand about 4 inches thick. The underlying material is light gray fine sand stratified with thin layers of grayish brown loamy fine sand. Mottles are below a depth of 40 inches.

Included with these soils in mapping are areas of Boel, Els, and Marlake soils. The somewhat poorly drained Boel and Els soils are in transitional areas between the Tryon and Inavale soils on the landscape. The very poorly drained Marlake soils are in lower positions and have a higher seasonal water table. Included soils make up 10 to 15 percent of this map unit.

Permeability is rapid, and the available water capacity is low in both the Tryon and Inavale soils. The organic matter content is high in the Tryon soil and low in the

Figure 16.—Typical area of Tryon-Inavale complex, channeled. The Inavale soil is on the higher lying areas.

Inavale soil. Both soils are low in natural fertility. The Tryon soil is medium acid to mildly alkaline, and the Inavale soil is slightly acid or neutral. Runoff is very slow. The seasonal high water table in the Tryon soil ranges from at the surface in wet years to a depth of 1.5 feet in dry years. During dry periods, the water table can recede to a depth of 5 to 6 feet. The water table in the Inavale soil is normally below a depth of 6 feet. The depth to the water table is directly affected by the depth of water flowing in the nearby stream.

All of the acreage of this complex is in rangeland. The areas are used mostly for grazing, but a few small areas adjacent to meadows are cut for hay.

The Tryon soil is too wet for cultivated crops.

Areas of these soils are difficult to hay because they are cut into small tracts by the meandering stream channels. In a few places, the stream channels have been straightened. This complex is suitable for rangeland. Overgrazing by livestock or improper timing of haying reduces the protective cover and causes deterioration of the native plants. Proper grazing use and timely deferment from grazing help to maintain and increase grass production and prevent the development of boggy conditions. Boggy conditions develop in pastures that are grazed when the water table is at the surface. Floods can deposit trash and debris and cause some damage to fences in these areas.

This complex is unsuited to trees and shrubs planted in windbreaks because of excess wetness from the high water table and the hazard of flooding. Some areas can be used for recreational, wildlife, or forestation plantings of tolerant trees and shrubs if they are planted by hand or other approved special practices are used.

These soils are generally not suited to use as septic tank absorption fields, sewage lagoons, and building sites because of flooding. A suitable alternate site is needed. Constructing roads on suitable, well compacted fill material above the flooding level and providing adequate side ditches and culverts help to protect roads from damage by flooding and wetness.

This complex is in capability unit VIw-7 dryland and windbreak suitability group 10. The Tryon soil is in the Wet Subirrigated range site, and the Inavale soil is in the Sandy Lowland range site.

VaB—Valentine fine sand, 0 to 3 percent slopes. This soil is deep, excessively drained, and nearly level to very gently sloping. It is in enclosed valleys within the sandhills and in sandy transitional areas adjacent to the sandhills. It occupies mostly low, hummocky topography. Individual areas range from 5 to 1,000 acres or more.

Typically, the surface layer is grayish brown, loose fine sand about 8 inches thick. The transitional layer is brown, loose fine sand about 7 inches thick. The underlying material is pale brown and very pale brown fine sand to a depth of more than 60 inches. In places, loamy material is below a depth of 40 inches. In a few places, coarse sand is below a depth of 20 inches.

Included with this soil in mapping are small areas of Els, Ipage, Marlake, and Tryon soils. Els, Marlake, and Tryon soils are in the valleys or swales and are affected by a high water table. Ipage soils are slightly lower on the landscape and are moderately well drained. Also included with this soil in mapping are a few small areas of Blownout land. Included soils make up less than 15 percent of the map unit.

Permeability of this Valentine soil is rapid, and the available water capacity is low. Natural fertility and the organic matter content are low. The soil is slightly acid or neutral. The water intake rate is very high, and runoff is slow.

Most of the acreage of this soil is in native grass and is used as range or hayland. A few areas are used as irrigated cropland.

Under dryland farming, this soil is unsuited to cultivated crops because of droughtiness and the hazard of soil blowing.

Under irrigation, this soil is poorly suited to corn, alfalfa, and introduced grasses. It is unsuited to gravity methods of irrigation, but it can be sprinkler irrigated. Water should be applied frequently and in small amounts to prevent leaching of plant nutrients. Soil blowing is a hazard where the surface is not adequately protected by growing crops or crop residue. Using close-growing crops, leaving crop residue on the surface, and using winter cover crops help to control soil blowing. Adding barnyard manure helps to maintain fertility and increase the organic matter content. Grazing of crop residue should be restricted to insure maximum crop residue cover.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover, cause deterioration of the native plants, and can cause severe losses by soil blowing and create small blowouts. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition. Livestock distribution can be improved by proper placement of fences, salt, and water.

This soil is suited to trees and shrubs planted in windbreaks. Areas of this soil are so loose that trees planted in windbreaks need to be planted in shallow furrows with as little disturbance of the soil as possible. Young seedlings can be damaged by high winds and covered by drifting sand. Weeds and undesirable grasses near the trees can be controlled by timely use of herbicides or cultivation.

This soil is generally suited to use as sites for dwellings, small commercial buildings, and local roads and streets. If this soil is used for septic tank absorption fields, care should be taken so that pollution by seepage does not contaminate nearby water supplies. The soil readily absorbs effluent from absorption fields, but it does not adequately filter it. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

This Valentine soil is in capability units VIe-5 dryland and IVe-12 irrigated. It is in the Sandy range site and windbreak suitability group 7.

VaD—Valentine fine sand, 3 to 9 percent slopes. This soil is deep, gently sloping to strongly sloping, and excessively drained. It occupies hummocky dunes on the uplands where slopes are complex. Individual areas range from 5 to 1,000 acres.

Typically, the surface layer is grayish brown, loose fine sand about 5 inches thick. The transitional layer is pale brown, loose fine sand about 5 inches thick. The underlying material is very pale brown fine sand to a depth of more than 60 inches. In a few places, buried loamy layers are between depths of 20 and 40 inches.

Included with this soil in mapping are small areas of Els, Ipage, Marlake, and Tryon soils. These soils all occupy lower positions on the landscape. Els soils are somewhat poorly drained. Marlake soils are very poorly drained, and Tryon soils are poorly drained or very poorly drained. Ipage soils are slightly higher than Els, Marlake, and Tryon soils and are moderately well drained. Also included with this soil in mapping are some small blow-outs. Included soils make up 10 to 15 percent of this map unit.

Permeability of this Valentine soil is rapid, and the available water capacity is low. Natural fertility and the organic matter content are low. The soil is slightly acid or neutral throughout. The water intake rate is very high. Runoff is slow.

Most of the acreage of this soil is in native grass and is used as rangeland. A few areas are cultivated and irrigated by sprinkler systems.

Under dryland farming, this soil is unsuited to crops because of droughtiness and the hazard of soil blowing.

Under irrigation, this soil is poorly suited to corn, soybeans, alfalfa, small grains, and introduced grasses where slopes do not exceed 6 percent. Alfalfa, small grains, and introduced grasses are suited where slopes are 6 to 9 percent. This soil is not suitable for gravity methods of irrigation but can be sprinkler irrigated (fig. 17).

Frequent and light applications of water are needed to avoid excessive leaching of plant nutrients. Soil blowing is a hazard where the surface is not adequately protected by growing crops or crop residue. Using close-growing crops, leaving crop residue on the surface, and using winter cover crops help to control soil blowing. To obtain maximum crop residue cover, removal of crop residue should be limited, and grazing of the crop residue should be restricted. Barnyard manure helps to maintain fertility and the organic matter content.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover, cause deterioration of the native plants, and can cause severe losses by soil blowing and create small blow-outs. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition. More nearly uniform grazing can be obtained by proper placement of fences and salt and water facilities.

This soil is suited to trees and shrubs planted in windbreaks. This soil is so loose that trees need to be planted in shallow furrows with as little disturbance of the soil as possible. Young seedlings can suffer from sand blasting or be covered by drifting sand during high winds. Maintaining strips of sod or other vegetation between the rows reduces soil blowing and helps to control weeds and undesirable grasses that compete with the trees for moisture. Weeds in areas near the trees can be controlled by using appropriate herbicides or by hand cultivation.

This soil is generally suited to use as sites for dwellings, small commercial buildings, and local roads

Figure 17.—Corn growing on Valentine fine sand, 3 to 9 percent slopes, under center-pivot sprinkler irrigation.

and streets. If this soil is used for septic tank absorption fields, care should be taken so that pollution by seepage does not contaminate nearby water supplies. The soil readily absorbs effluent from septic tank absorption fields, but it does not adequately filter the effluent. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. In places, small commercial buildings need to be properly designed to accommodate the slope, or the soil can be graded to an acceptable gradient.

This Valentine soil is in capability units VIe-5 dryland and IVe-12 irrigated. It is in the Sands range site and windbreak suitability group 7.

VaE—Valentine fine sand, rolling. This soil is deep and excessively drained. Slopes range from 9 to 17 percent. The soil is in areas of hummocky dunes in the sandhills (fig. 18). Individual areas range from 10 to several thousand acres.

Typically, the surface layer is grayish brown, loose fine sand about 5 inches thick. The transitional layer is light brownish gray, loose fine sand about 4 inches thick. The underlying material is pale brown fine sand to a depth of more than 60 inches. In places, the surface layer is loamy sand or loamy fine sand.

Included with this soil in mapping are small areas of Els, Ipage, and Tryon soils. Els and Tryon soils are in swales and are affected by a high water table. Ipage soils are between the Valentine and Els soils and are moderately well drained. Small blowouts are common. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Valentine soil is rapid, and the available water capacity is low. Natural fertility and the organic matter content are low. The soil is slightly acid or neutral. Runoff is slow.

Areas of this soil are in native grass and are used mostly as rangeland. A few of the lower lying areas are periodically cut for hay.

This soil is unsuited to crops because of the steepness of slopes.

This soil is suited to rangeland. This use is effective in controlling soil blowing and water erosion. Areas that have been cultivated need to be seeded to native grass. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Overgrazing also can cause severe losses by soil blowing and create small blowouts. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition. Large blowouts in the range areas need to be shaped and reseeded. A mulch is needed to hold the soil in place while the seedlings become established. The newly seeded area should be fenced to keep livestock from overgrazing the area. Livestock distribution can be improved by proper placement of fences and salt and water facilities.

This soil is suited to trees and shrubs planted in windbreaks. The soil is so loose that trees need to be planted in shallow furrows with as little disturbance of the soil as possible. Strips of sod or other vegetation need to be maintained between the tree rows to control soil blowing. Young seedlings can suffer from sand blasting during high winds and be covered by drifting sand. Weeds and undesirable grasses can be controlled by hand cultivation or by using the appropriate herbicide.

If this soil is used for septic tank absorption fields, care should be taken so that pollution by seepage does not contaminate nearby water supplies. This soil readily absorbs effluent from absorption fields, but it does not adequately filter the effluent. Sewage lagoons need to be lined or sealed to prevent seepage. Grading is required to modify the slope and shape sewage lagoons. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Dwellings and small commercial buildings need to be properly designed to accommodate the slope, or the soil can be graded to an acceptable gradient. Cuts and fills are generally needed to provide a suitable grade for roads and streets.

This Valentine soil is in capability unit VIe-5 dryland. It is in the Sands range site and windbreak suitability group 7.

VaG—Valentine fine sand, rolling and hilly. This deep, excessively drained soil is in areas where rolling and hilly landscapes are closely intermingled. Each type of landscape makes up about 20 to 75 percent of a mapped area. The hilly part is steeper and commonly higher in elevation than the rolling part. Most of the very steep areas have irregular catsteps on the side slopes. Slopes range from 17 to 60 percent. Individual areas range from 40 to several thousand acres.

Typically, the surface layer is light brownish gray, loose fine sand about 3 inches thick. The underlying material is very pale brown fine sand to a depth of more than 60 inches.

Included with this soil in mapping are small areas of Els, Ipage, and Valentine soils that have gentler slopes. Els and Ipage soils are lower on the landscape. Ipage soils are moderately well drained. Els soils are somewhat poorly drained. Also included are a few blowouts. Included soils make up less than 10 percent of the map unit.

Permeability of this Valentine soil is rapid, and the available water capacity is low. Natural fertility and the organic matter content are low. The soil is slightly acid or neutral. Runoff is slow.

Areas of this soil are in native grass and are used as range.

This soil is unsuited to crops because of the steep slopes.

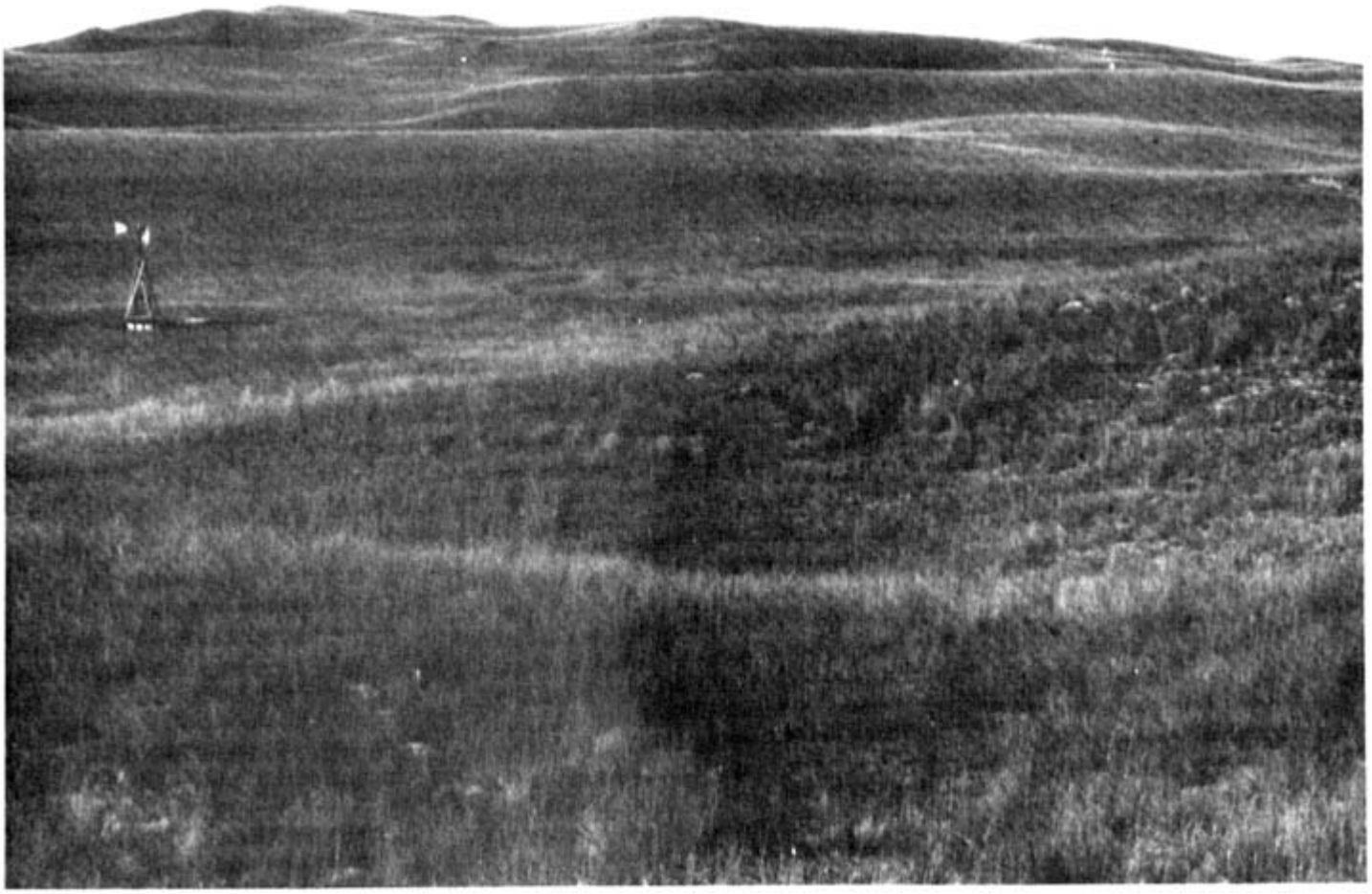


Figure 18.—Typical landscape in an area of Valentine fine sand, rolling.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. It also can cause severe soil blowing and create large blowouts. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve the range condition. Uniform grazing can be achieved by proper placement of fences and salt and water facilities. Slopes are so steep in the hilly parts that it is difficult for range animals to move over the areas. Vegetation is commonly sparser on the hilly part than on the rolling part.

This soil generally is unsuited to trees and shrubs planted in windbreaks. Some areas can be used for recreational and wildlife plantings of tolerant trees or shrubs if they are hand planted or other approved special practices are used. Onsite investigation may locate small areas suitable for plantings.

This soil generally is not suited to sanitary facilities because of the steep slopes. A suitable alternate site is needed. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Slope increases the difficulty of digging. Cuts and fills are generally needed to provide a suitable grade for roads and streets.

This Valentine soil is in capability unit VIIe-5 dryland. It is in the Sands and Choppy Sands range sites and windbreak suitability group 10.

VeB—Valentine-Dunday loamy fine sands, 0 to 3 percent slopes. This complex consists of deep, nearly level to very gently sloping, excessively drained

Valentine soil and somewhat excessively drained Dunday soil on sandy uplands. Individual areas range from 5 to 1,000 acres. The complex is 60 to 70 percent Valentine soil and 20 to 30 percent Dunday soil. The Valentine soil is mostly on slightly convex areas, and the Dunday soil is mostly in swales. The two soils are so intricately mixed that it was not practical to separate them in mapping.

Typically, the Valentine soil has a surface layer of dark grayish brown, very friable loamy fine sand about 7 inches thick. The transitional layer is grayish brown, loose fine sand about 9 inches thick. The underlying material is pale brown and very pale brown fine sand to a depth of more than 60 inches. In places, the surface layer is sand or fine sand.

Typically, the Dunday soil has a dark gray, very friable loamy fine sand surface layer about 8 inches thick. The subsurface layer is dark grayish brown, very friable loamy fine sand about 6 inches thick. The transitional layer is grayish brown, very friable loamy fine sand about 6 inches thick. The underlying material is fine sand that is pale brown in the upper part and very pale brown in the lower part. It extends to a depth of more than 60 inches. In places, this soil is dark to a depth of more than 20 inches.

Included with these soils are small areas of Boelus, Ipage, Pivot, and Simeon soils. These soils are in similar positions on the landscape. The Boelus soil has loamy underlying material. The Ipage soil has mottles above a depth of 40 inches. Pivot and Simeon soils contain more gravel. Included soils make up 10 to 15 percent of this complex.

Permeability of the Valentine and Dunday soils is rapid, and the available water capacity is low. The organic matter content and natural fertility are low in the Valentine soil. The organic matter content is moderately low, and the natural fertility is low in the Dunday soil. These soils have a very high water intake rate, and runoff is slow. Both soils range from slightly acid to neutral throughout the profile. Tilth is good, and these soils are easily tilled throughout a wide range in moisture content.

Most areas of this complex are in native grass and are used as range or hayland. The remaining acreage is cropland, and most of the cropland is irrrigated by sprinkler systems.

Under dryland farming, this complex is poorly suited to corn, small grains, soybeans, and alfalfa. Small grains and the first cutting of alfalfa are generally better suited because they grow and mature in spring when the rainfall is highest. Soil blowing is a hazard where the surface is not adequately protected by growing crops or crop residue. Soil blowing can be reduced, moisture conserved, and organic matter content and fertility maintained by using a cropping system that keeps the soil covered with crops, grass, or crop residue. Row crops need to be limited in the cropping sequence, and maximum use needs to be made of close-growing crops that protect the soil and conserve moisture. Stripcropping and stubble mulch tillage can also be used to control soil blowing. Returning crop residue to the soil and using barnyard manure help to increase the organic matter content and improve fertility.

Under irrigation, this complex is suited to corn, soybeans, alfalfa, small grains, and introduced grasses. Sprinkler irrigation is the only method suited to these soils. The soils are too sandy for gravity irrigation. Frequent water applications are needed because the available water capacity is low, and light applications are needed to avoid leaching plant nutrients below the root zone. Soil blowing is a hazard where the surface is not adequately protected by growing crops or crop residue. Using stubble mulch tillage and winter cover crops help to control soil blowing (fig. 19). Returning crop residue to the soil increases the organic matter content and helps to maintain fertility.

This complex is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition. Distribution of livestock can be improved by correctly locating fences, livestock water, and salting facilities.

This complex is suited to trees and shrubs planted in windbreaks. Only trees and shrubs that are tolerant of sandy, droughty conditions are suited. Irrigation can provide supplemental water during times of insufficient rainfall. Soil blowing can be controlled by maintaining strips of sod or other vegetation between the rows. Weeds and undesirable grasses in the tree rows can be controlled by using the appropriate herbicides or by hand cultivation.

This complex is generally suited to use for dwellings, small commercial buildings, and local roads and streets. If these soils are used for septic tank absorption fields, care should be taken so that pollution by seepage does not contaminate nearby water supplies. These soils readily absorb effluent from absorption fields, but they do not adequately filter the effluent. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving.

This complex is in capability units IVe-5 dryland and IVe-11 irrigated. The soils are in the Sandy range site and windbreak suitability group 5.

VeD—Valentine-Dunday loamy fine sands, 3 to 9 percent slopes. This complex consists of deep, gently sloping and strongly sloping, excessively drained Valentine soil and somewhat excessively drained Dunday soil on uplands. Individual areas range from 5 to 600

Figure 19.—In areas cut for silage, rye planted between the corn rows in the fall provides a winter cover crop that helps to control soil blowing and catch drifting snow on this area of Valentine-Dunday loamy fine sands, 0 to 3 percent slopes.

acres. The complex is 60 to 70 percent Valentine soil and 20 to 30 percent Dunday soil. The Valentine soil is mostly on convex upper side slopes and ridgetops or in places where erosion has thinned the surface layer. The Dunday soil is mostly on concave lower side slopes and in swales. The two soils are so intricately mixed that it was not practical to separate them in mapping.

Typically, the Valentine soil has a surface layer of dark grayish brown, very friable loamy fine sand about 5 inches thick. The transitional layer is grayish brown, loose fine sand about 5 inches thick. The underlying material is pale brown fine sand to a depth of more than 60 inches. In places, the surface layer is sand or fine sand. Loamy material is at a depth of 40 to 60 inches in places.

Typically, the Dunday soil has a surface layer that is dark gray, very friable loamy fine sand about 6 inches thick. The subsurface layer is dark grayish brown, very friable loamy sand about 4 inches thick. The transitional layer is brown, loose fine sand about 8 inches thick. The underlying material is pale brown fine sand to a depth of more than 60 inches. In places, the surface layer is sand. In a few places, this soil is dark to a depth of more than 20 inches.

Included with these soils in mapping are small areas of Boelus, Ipage, and Simeon soils. Boelus soils have loamy underlying material and occupy similar positions on the landscape. Ipage soils are lower on the landscape and have mottles at a depth of less than 40 inches. Simeon soils occupy similar positions on the landscape and have underlying material of coarse sand. Included soils make up 10 to 15 percent of this complex.

Permeability of the Valentine and Dunday soils is rapid, and the available water capacity is low. The organic matter content is low in the Valentine soil and moderately low in the Dunday soil. The natural fertility is low in both soils. Both soils are slightly acid or neutral. These soils have a very high water intake rate, and runoff is slow. These soils are easily tilled throughout a wide range in moisture content.

A large acreage of this complex is in native grass and is used for grazing. The remainder is used mostly as irrigated cropland.

Under dryland farming, this complex is generally unsuited to cropland because of droughtiness and the hazard of soil blowing. However, some areas are being cultivated along with larger areas of arable soils.

Under irrigation, this complex is poorly suited to corn, alfalfa, introduced grasses, and small grains. Only sprinkler irrigation systems are suited to these soils. The soils are too sandy for gravity irrigation. They require frequent, light applications of water to prevent leaching of plant nutrients below the root zone. Soil blowing is a hazard where the surface is not adequately protected by growing crops or crop residue. Cornstalks need to be managed so that the maximum amount of crop residue remains on the surface to reduce soil blowing in the winter and spring. To obtain maximum crop residue cover, removal of the crop residue should be limited, and grazing of the crop residue should be restricted. Stubble mulch tillage and using winter cover crops help to control soil blowing. Keeping tillage to a minimum, using field windbreaks, and applying fertilizer help to control soil blowing and maintain fertility.

This complex is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. They also can cause severe losses by soil blowing. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition. Livestock distribution can be improved by proper placement of fences and water and salting facilities.

This complex is suited to trees and shrubs planted in windbreaks. Only species that are tolerant of sandy, droughty conditions are suited. Inadequate moisture and soil blowing are the main problems. Irrigation can provide supplemental moisture during periods of low rainfall. The Valentine soil is so loose that trees need to be planted in shallow furrows with as little disturbance of the soil as possible. Soil blowing can be prevented by maintaining strips of sod or other vegetation between the rows. Young seedlings can suffer from sand blasting during high winds and be covered by drifting sand. Competition for moisture from weeds and undesirable grasses is a problem. Weeds can be controlled by cultivating or by timely use of herbicides. Areas near the trees can be hoed by hand or rototilled.

This complex is generally suited to use as sites for dwellings, small commercial buildings, and local roads and streets. If these soils are used for septic tank absorption fields, care should be taken so that pollution by seepage does not contaminate nearby water supplies. These soils readily absorb effluent from absorption fields, but they do not adequately filter the effluent. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. In places, small commercial buildings need to be designed to accommodate the slope, or the soil can be graded to an acceptable gradient.

This complex is in capability units VIe-5 dryland and IVe-11 irrigated and in the Sandy range site. The Valentine soil is in windbreak suitability group 7, and the Dunday soil is in windbreak suitability group 5.

VmD—Valentine-Els complex, 0 to 9 percent slopes. This complex consists of deep, excessively drained, gently sloping to strongly sloping Valentine soil and deep, nearly level, somewhat poorly drained Els soil in areas of sandhills. Individual areas range from 10 to 3,000 acres. The complex is 50 to 65 percent Valentine soil and 20 to 35 percent Els soil. Valentine soil is on the dunes. Els soil is in the swales between the dunes and is rarely flooded. The two soils are so intricately mixed that it was not practical to separate them in mapping.

Typically, the Valentine soil has a surface layer of grayish brown, loose fine sand about 5 inches thick. The transitional layer is light brownish gray, loose fine sand about 5 inches thick. The underlying material is pale brown fine sand to a depth of more than 60 inches. In a few places, the surface layer is loamy sand or loamy fine sand.

Typically, the Els soil has a surface layer of dark grayish brown, very friable loamy fine sand about 7 inches thick. The transitional layer is light brownish gray, loose fine sand about 6 inches thick. The underlying material is light gray and very pale brown fine sand that has strong brown mottles to a depth of more than 60 inches. In a few places, the surface layer is fine sand. In a few places, the surface layer is more than 9 inches thick. In a few places, loamy layers or gravelly material is below a depth of 20 inches.

Included with these soils in mapping are small areas of Ipage, Loup, Marlake, and Tryon soils. Ipage soils are on the landscape between the Valentine and Els soils and have mottles at a depth of less than 40 inches. Loup, Marlake, and Tryon soils are lower than Els soils on the landscape. Marlake soils are very poorly drained. Loup and Tryon soils are poorly drained or very poorly drained. Also included are some areas of Valentine soils that have steeper slopes. Blow-outs are common. Included soils make up 10 to 15 percent of the complex.

Permeability is rapid in both the Valentine and Els soils. Both soils have low available water capacity and

low natural fertility. The organic matter content is low in the Valentine soil and moderately low in the Els soil. The Valentine soil is slightly acid or neutral. The Els soil is neutral to mildly alkaline. These soils have a very high water intake rate. Runoff is slow to very slow. The seasonal high water table is below a depth of 6 feet in the Valentine soil. The seasonal high water table in the Els soil ranges from a depth of about 1.5 feet in wet years to about 2.5 feet in dry years.

Most of the acreage of this complex is in native grass and is used as range or hayland. A small acreage is used as irrigated cropland.

Under dryland farming, this complex is unsuited to crops because of droughtiness and the hazard of soil blowing.

Under irrigation, this complex is poorly suited to small grains, alfalfa, and introduced grasses. Corn and soybeans are poorly suited in areas where slopes are less than 6 percent. These soils are unsuited to gravity irrigation, but they can be sprinkler irrigated. Wetness caused by the high water table can be a problem during the wettest seasons, but during dry years the crops can benefit from subirrigation. Artificial drainage may be needed. Soil blowing is a hazard where the surface is not adequately protected by growing crops or crop residue. It can be controlled by using winter cover crops, using close-growing crops, and leaving crop residue on the surface. Grazing of crop residue by livestock should be limited. Barnyard manure increases the organic matter content and improves fertility.

This complex is suited to rangeland, either grazing or haying. This use is effective in controlling soil blowing. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and restricted use during very wet periods help to maintain or improve the range condition. More nearly uniform grazing can be obtained by proper placement of fences and salt and water facilities.

This complex is suited to trees and shrubs planted in windbreaks. The Valentine soil is so loose that trees need to be planted in shallow furrows with as little disturbance of the soil as possible. Young seedlings can suffer from sand blasting or be covered by drifting sand during high winds. Strips of sod should be maintained between the tree rows. The species selected for planting on the Els soil should be those that can tolerate occasional wetness. Establishing trees can be a problem in wet seasons. Weeds and undesirable grasses are a problem, but they can be controlled by cultivating with conventional equipment or by timely use of herbicides. Areas near the trees can be rototilled or hoed by hand.

If this complex is used for septic tank absorption fields, care should be taken so that pollution by seepage does not contaminate the underground water table. The soils readily absorb effluent from absorption fields, but they do not adequately filter it. Absorption fields on the Els soil can be constructed on fill material so that the absorption field can be placed a sufficient distance above the seasonal high water table. Sewage lagoons need to be lined or sealed to prevent seepage. Sewage lagoons on the Els soil need to be constructed on fill material to raise the lagoon above the seasonal high water table. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Digging in the Els soil when the soil is dry is easier and helps to avoid caving and water problems. The Valentine soil is generally suited to dwellings, small commercial buildings, and local roads and streets. In places, the small commercial buildings may need to be designed to accommodate the slopes, or the soil can be graded to an acceptable gradient. Dwellings and small commercial buildings on Els soil can be constructed on elevated, well compacted fill material as protection against flooding and to overcome wetness from the high water table. Constructing roads and streets on Els soil requires suitable, well compacted fill material and adequate side ditches and culverts to protect roads from flooding and wetness. On Els soil, damage to roads by frost action can be reduced by providing good surface drainage and by the use of a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing adequate side ditches help to provide the needed surface drainage.

This complex is in capability units VIe-5 dryland and IVe-12 irrigated. The Valentine soil is in the Sands range site and windbreak suitability group 7. The Els soil is in the Subirrigated range site and windbreak suitability group 2S.

VsD—Valentine-Simeon sands, 3 to 9 percent slopes. These deep, gently sloping to strongly sloping, excessively drained soils are on side slopes. This complex is 40 to 50 percent Valentine soil and 35 to 50 percent Simeon soil. Typically, the Valentine soil is on mid and lower side slopes, and the Simeon soil is on upper side slopes or ridgetops. On some of the side slopes, the two soils are intermixed. Individual areas range from 10 to 500 acres.

Typically, the Valentine soil has a surface layer of grayish brown, loose sand about 5 inches thick. The transitional layer is light gray, loose sand about 7 inches thick. The underlying material is pale brown sand to a depth of more than 60 inches. In a few places, loamy material or shale is below a depth of 40 inches. In places, the surface layer is loamy sand or loamy fine sand.

Typically, the Simeon soil has a surface layer of dark grayish brown, loose sand about 6 inches thick. The transitional layer is grayish brown, loose sand about 8 inches thick. The underlying material is very pale brown, coarse sand to a depth of more than 60 inches. Fine gravel is throughout the profile. In places, the surface layer is loamy sand or loamy fine sand. In places, layers

of gravelly coarse sand or fine sand are in the underlying material. In a few places, loamy material or shale is below a depth of 40 inches.

Included with these soils in mapping are small areas of Dunday, Meadin, Pivot, and Wewela soils. Dunday soils are on lower foot slope positions and are dark to a depth of more than 9 inches. Meadin soils are in similar positions on the landscape as Simeon soils and are shallow over gravelly coarse sand. Pivot soils are on the upper side slopes and have gravelly coarse sand at a depth of 20 to 40 inches. Wewela soils are on lower side slopes near the bottom of drains and have a clayey lower part of the subsoil. Included soils make up 5 to 15 percent of the complex.

Permeability is rapid, and the available water capacity is low in both the Valentine and Simeon soils. Both soils have low organic matter content and natural fertility. Runoff is slow. Both soils are slightly acid or neutral. The water intake rate for irrigation is very high.

Most areas of these soils are in native grass and are used as range. A few areas are used as irrigated cropland.

This complex is unsuited to dryland farming because of droughtiness and the hazard of soil blowing.

Under irrigation, the complex is poorly suited to small grains, introduced grasses, and alfalfa. Corn and soybeans are poorly suited where slopes are less than 6 percent. This complex is not suited to gravity irrigation, but it can be sprinkler irrigated. Frequent, light applications of water are needed to avoid excessive leaching of plant nutrients below the root zone. Soil blowing is a hazard where the surface is not protected by growing crops or crop residue. Using close-growing crops, leaving crop residue on the surface, and planting winter cover crops are needed to control soil blowing. Grazing of crop residue should be limited to maintain maximum crop residue cover during winter. Heavy applications of barnyard manure help to increase the organic matter content and improve fertility.

This complex is suited to rangeland. This use is effective in controlling soil blowing. The soils are subject to severe blowing if the grass cover is destroyed by overgrazing or by trampling livestock. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain and improve range condition.

The Valentine soil is suited to trees and shrubs planted in windbreaks. The Simeon soil is unsuited. However, both soils are intermixed and should be managed as one unit. These soils are so loose that trees need to be planted in shallow furrows with as little disturbance of the soil as possible. Generally these soils are too droughty for good survival and growth of trees unless the trees can be watered. Soil blowing is a hazard, and seedlings can be damaged by the wind or covered by drifting sand. Strips of sod or other vegetation need to be maintained between the tree rows. Weeds and undesirable grasses in areas next to the trees can be rototilled or hoed by hand. Timely applications of the appropriate herbicides can also be used to control weeds and undesirable grasses.

This complex is suited to the construction of dwellings, small commercial buildings, and local roads and streets. If these soils are used for septic tank absorption fields, care should be taken so that pollution by seepage does not contaminate nearby water supplies. The soils readily absorb the effluent from absorption fields, but they do not adequately filter the effluent. Sewage lagoons need to be lined or sealed to prevent seepage. The walls or sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Small commercial buildings need to be designed to accommodate the slope in some places, or the soil graded to an acceptable gradient.

This complex is in capability units VIe-5 dryland and IVe-12 irrigated. The Valentine soil is in the Sands range site and windbreak suitability group 7. The Simeon soil is in the Shallow to Gravel range site and windbreak suitability group 10.

VsF2—Valentine-Simeon sands, 9 to 30 percent slopes, eroded. These strongly sloping to steep, excessively drained soils are mostly on upland side slopes along major drainageways that drain to the Niobrara River. These areas are erosive, and many have numerous small gullies. Individual areas of this complex range from 10 to over 500 acres. The complex is 40 to 50 percent Valentine soil and 35 to 50 percent Simeon soil. Valentine soil is mostly on mid and lower side slopes, and Simeon soil is mostly on upper side slopes and shoulders.

Typically, the Valentine soil has a surface layer of grayish brown loose sand about 5 inches thick. The transitional layer is pale brown loose sand about 5 inches thick. The underlying material is very pale brown sand to a depth of more than 60 inches. In places, the surface layer is loamy sand or loamy fine sand. In a few places, loamy material or shale is below a depth of 40 inches. In places, the surface layer is loamy sand or loamy fine sand.

Typically, the Simeon soil has a surface layer of grayish brown loose sand about 4 inches thick. The transitional layer is brown loose sand about 8 inches thick. The underlying material is very pale brown coarse sand to a depth of more than 60 inches. Fine gravel is throughout the profile. In places, the surface layer is loamy sand or loamy fine sand. In places, layers of gravelly coarse sand or fine sand are in the underlying material. In a few places, loamy material or shale is below a depth of 40 inches. In places, the surface layer is loamy sand or loamy fine sand.

Included with these soils in mapping are small areas of Dunday, Meadin, Pivot, and Wewela soils. Dunday soils are lower on the landscape and are dark to a depth of

more than 9 inches. Meadin and Pivot soils are on upper side slopes in similar positions as the Simeon soils and are shallow and moderately deep over gravelly coarse sand. Wewela soils are on lower side slopes near the bottom of drains and have a clayey lower part of the subsoil. Included soils make up 10 to 15 percent of the complex.

Permeability is rapid, and the available water capacity is low in both the Valentine and Simeon soils. Both soils have low organic matter content and natural fertility. Surface runoff is slow to medium. Both soils are slightly acid or neutral.

Areas of this complex are in native grass and are used for grazing.

This complex is unsuited to cultivation because the areas are too steep and erosive.

This complex is suited to rangeland. This use is effective in controlling soil blowing and water erosion. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. It also can cause severe gullying on the steep areas. Proper use, timely deferment from grazing, and a planned grazing system help to maintain or improve the range condition.

The only part of this complex suited to trees and shrubs planted in windbreaks is areas of the Valentine soil on slopes of less than 17 percent. Because of the intermixed composition of these soils, they should be treated as one unit. Generally these soils are too droughty, too sandy, and too steep to provide good sites for planting trees. Trees need to be planted in shallow furrows with as little disturbance of the soil as possible. Some areas can be used for recreational and wildlife planting of tolerant trees or shrubs if they are planted by hand or other approved special practices are used.

If these soils are used for septic tank absorption fields, care should be taken so that pollution by seepage does not contaminate nearby water supplies. These soils readily absorb effluent from septic tank absorption fields, but they do not adequately filter the effluent. Land shaping and installing the septic tank absorption field on the contour are generally necessary for its proper operation. Slopes of more than 15 percent are not suitable for sanitary facilities because of the steep slopes. A suitable alternate site is needed. If sewage lagoons are constructed, extensive grading is required to modify the slope and shape the lagoon. Sewage lagoons need to be lined or sealed to prevent seepage. The walls and sides of shallow excavations can be temporarily shored to prevent sloughing or caving. Slope increases the difficulty of digging. Dwellings and small commercial buildings need to be properly designed to accommodate the slope, or the soil can be graded to an acceptable gradient. Cuts and fills are generally needed to provide a suitable grade for roads and streets.

This complex is in capability unit VIe-5 dryland. The Valentine soil is in the Sands range site, and the Simeon is in the Shallow to Gravel range site. Both soils are in windbreak suitability group 10.

Vte—Valentine-Tryon fine sands, 0 to 17 percent slopes. This complex consists of excessively drained Valentine soils and very poorly drained Tryon soil (fig. 20). The Valentine soil is gently sloping to moderately steep and is on the sandy ridges. The Tryon soil is nearly level and in the swales between the ridges that rarely flood. Individual areas range from 10 to several thousand acres. The complex is about 40 to 65 percent Valentine soil and 20 to 30 percent Tryon soil. The two soils are so intricately mixed that it was not practical to separate them in mapping.

Typically, the Valentine soil has a grayish brown, loose fine sand surface layer about 4 inches thick. The transitional layer is light brownish gray, loose fine sand about 4 inches thick. The underlying material is pale brown fine sand that extends to a depth of 60 inches or more.

Typically, the Tryon soil has a dark grayish brown, loose fine sand surface layer about 5 inches thick. The underlying material is light brownish gray and light gray fine sand that extends to a depth of 60 inches or more. In places, the surface layer is loamy sand. In places, the surface layer is more than 9 inches thick.

Included with these soils in mapping are small areas of Els, Elsmere, Ipage, and Marlake soils. Els, Elsmere, and Ipage soils are on the landscape between the Valentine and Tryon soils. Els and Elsmere soils are somewhat poorly drained, and Ipage soils are moderately well drained. Marlake soils are in the lowest positions on the landscape and have a higher seasonal water table than Tryon soils. Included soils make up 5 to 10 percent of this complex.

Permeability is rapid, and the available water capacity is low in both the Valentine and Tryon soils. The organic matter content is low in the Valentine soil and high in the Tryon soil. Natural fertility is low in both soils. The Valentine soil is medium acid to neutral. The Tryon soil is medium acid to moderately alkaline. Runoff is very slow. The seasonal high water table in the Tryon soil ranges from a depth of about 0.5 foot above the surface in wet years to a depth of about 1 foot in dry years. Water sometimes ponds on the surface for a week or two in the spring and during other wet periods.

Areas of this complex are in native grass and are used as rangeland.

Areas of this complex are unsuited to cultivated crops under dryland or irrigation management because of the hazard of soil blowing and severe wetness.

This complex is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights can cause deterioration of the native plants. If

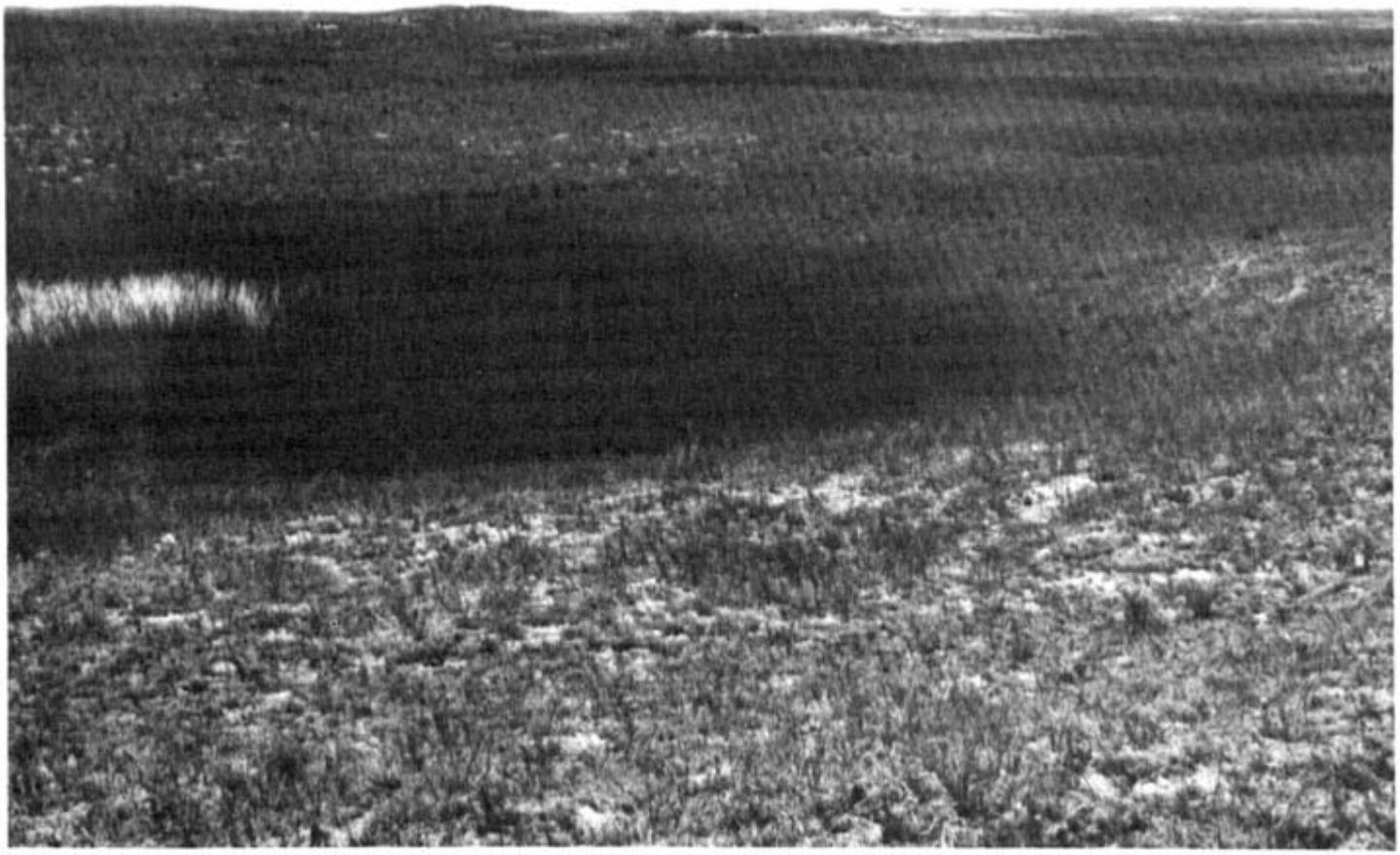


Figure 20.—Typical landscape in an area of Valentine-Tryon fine sands, 0 to 17 percent slopes. The Valentine soil is on the ridges and the Tryon soil is in the pockets and swales. The Tryon soil ponds water during wet periods.

the Tryon soil is wet, overgrazing can cause surface compaction and small mounds, making it difficult to graze or harvest for hay. The Valentine soil has an abnormally high percentage of sandhill muhly growing on it. Proper grazing use, timely deferment from grazing, and restricted use during wet periods help to maintain the native plants and improve the range condition.

The Valentine soil is suited to trees and shrubs planted in windbreaks, but the Tryon soil is unsuited because of wetness. Onsite investigation is needed to select suitable sites for tree belts. Soil blowing and droughtiness are problems on the Valentine soil. Trees need to be planted in a shallow furrow with as little disturbance of the soil as possible. Irrigation can provide supplemental water during times of insufficient moisture. Competition from weeds and undesirable grasses can be controlled by maintaining strips of sod between the rows and in the rows. Areas near the trees can be hoed by hand.

Onsite investigation is needed prior to any engineering use of this complex. The Valentine soil is the only part of this complex suited to septic tank absorption fields. This soil readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent. The poor filtering capacity can result in pollution of the underground water table. The Tryon soil is not suited to septic tank absorption fields because of ponding from the seasonal high water table. Sewage lagoons on Tryon soil need to be constructed on fill material to raise the bottom of the lagoon to a sufficient height above the seasonal high water table. Sewage lagoons on both Valentine and Tryon soils need to be lined or sealed to prevent seepage. Grading is required to modify the slope on the Valentine soil and to shape the sewage lagoon. The walls or sides of shallow excavations made in Valentine soils can be temporarily shored to prevent sloughing or caving. The Valentine soil is suited to building sites where slopes are less than 8 percent. On slopes of more than 8 percent, the buildings need to be properly designed to accommodate the

slope, or the soil can be graded to an acceptable gradient. The Tryon soil is not suitable for building sites because of ponding. Roads on the Tryon soil need to be constructed on suitable, well compacted fill material. Providing adequate side ditches and culverts helps to protect roads from damage by ponding and wetness. Cuts and fills are generally needed on the Valentine soil to provide a suitable grade for roads and streets.

This complex is in capability unit VIe-5 dryland. The Valentine soil is in the Sands range site and windbreak suitability group 7. The Tryon soil is in the Wetland range site and windbreak suitability group 10.

VwD—Valentine-Wewela complex, 3 to 9 percent slopes. This complex consists of deep, excessively drained Valentine soil and moderately deep, well drained Wewela soil. The Valentine soil is gently sloping to strongly sloping and on the dunes. The Wewela soil is gently sloping and in the swales. Individual areas range from 5 to 300 acres. The complex is 40 to 60 percent Valentine soil and 20 to 40 percent Wewela soil. The two soils are so intricately mixed that it was not practical to separate them in mapping.

Typically, the Valentine soil has a surface layer of dark grayish brown, loose fine sand about 6 inches thick. The transitional layer is grayish brown, loose fine sand about 6 inches thick. The underlying material is pale brown fine sand to a depth of 60 inches or more. In places, the surface layer is loamy fine sand or loamy sand. In places, shale is at a depth of 40 to 60 inches.

Typically, the Wewela soil has a dark gray, very friable loamy fine sand surface layer about 6 inches thick. The subsurface layer is grayish brown, very friable loamy fine sand about 4 inches thick. The subsoil is brown, friable sandy clay loam about 10 inches thick. The underlying material, about 9 inches thick, is light brownish gray shaly clay. Light brownish gray, calcareous, bedded shale is at a depth of about 29 inches. In places, the surface layer is fine sand or fine sandy loam. In places, the thickness of the sand over the clayey material ranges from 20 to 40 inches.

Included with these soils in mapping are small areas of Els, Elsmere, Ipage, and Labu soils. Els and Elsmere soils are somewhat poorly drained and in the swales. They are sandy throughout. Ipage soils are on low hummocks and have mottles at a depth of less than 40 inches. Labu soils are in swales and are clayey throughout. Included soils make up 5 to 15 percent of this complex.

Permeability in the Valentine soil is rapid. Permeability in the Wewela soil is moderate in the loamy material and slow in the underlying clayey material. The available water capacity is low in both soils. The Valentine soil is low in organic matter content. The Wewela soil is moderately low in organic matter content. Both soils are low in natural fertility. The Valentine soil is slightly acid to neutral. The Wewela soil is slightly acid to moderately alkaline. The water intake rate is high. Runoff is slow. Water ponds in some of the swales following heavy rains.

Most of the acreage of this complex is in native grass and is used for grazing or as hayland.

Under dryland farming, this complex is unsuited to cultivated crops because of the hazard of soil blowing and droughtiness.

Under irrigation management, this complex is poorly suited to small grains, alfalfa, and tame grasses. Corn and soybeans are poorly suited where slopes do not exceed 6 percent. These soils are not suited to gravity irrigation, but they can be sprinkler irrigated. Soil blowing is a hazard. A cropping system that includes legumes or grass-legume mixtures helps to increase organic matter content, improve fertility, and control soil blowing. Keeping crop residue on the surface controls soil blowing. Adding barnyard manure increases the organic matter content and improves fertility.

This complex is suited to rangeland, either grazing or haying. This use is effective in controlling soil blowing. Overgrazing by livestock, improper timing of haying, or improper mowing heights reduce the protective cover and cause deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition.

The Valentine soil is suited to trees and shrubs planted in windbreaks. The Wewela soil is poorly suited. Inadequate seasonal rainfall and soil blowing are the main problems. The soils are so loose that trees need to be planted in shallow furrows with as little disturbance of the soil as possible. Young seedlings can be damaged during high winds or covered by drifting sand. Maintaining strips of sod or other vegetation between the tree rows controls soil blowing. Growth of trees and shrubs is poor because of the low available water capacity. Irrigation can provide supplemental water during periods of low rainfall. Weeds and undesirable grasses can be controlled with conventional equipment and appropriate herbicides. Areas in the rows can be rototilled or hoed by hand. Onsite investigation is needed before this complex is used for trees.

Prior to any engineering uses of this complex, onsite investigation is needed. The Valentine soil readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent. The poor filtering capacity can result in pollution of nearby water supplies. Septic tank absorption fields are not suited to Wewela soil because of slow permeability. Sewage lagoons on Valentine soil need to be lined and sealed to prevent seepage. Sewage lagoons can be constructed on areas of Wewela soil if, after excavation, the bottom of the lagoon is sealed to prevent seepage. The walls or sides of shallow excavations in Valentine soil can be temporarily shored to prevent sloughing or caving. Digging in Wewela soil needs to be done when the soil

is moist but not wet. The Valentine soil generally is suited to use as sites for dwellings and local roads and streets. Small commercial buildings need to be properly designed to accommodate the slope, or the soil can be graded to an acceptable gradient. Foundations for buildings on Wewela soil need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Roads and streets on Wewela soil need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarser grained material for subgrade or base material can be used to ensure better performance. The base material for roads and streets on Wewela soil can be mixed with additives, such as hydrated lime, to help prevent shrinking and swelling.

This complex is in capability units VIe-5 dryland and IVe-12 irrigated. The Valentine soil is in the Sands range site and windbreak suitability group 7. The Wewela soil is in the Sandy range site and windbreak suitability group 4C.

Vx—Verdel silty clay loam, 0 to 2 percent slopes. This deep, nearly level, well drained soil is on stream terraces. It formed in clayey alluvium. Individual areas range from 5 to 100 acres.

The surface layer is dark grayish brown, friable silty clay loam about 6 inches thick. The subsurface layer is dark gray, firm silty clay about 6 inches thick. The subsoil is about 22 inches thick. It is dark grayish brown, firm silty clay in the upper part and grayish brown, firm, calcareous silty clay in the lower part. The underlying material is olive gray, calcareous silty clay to a depth of 60 inches or more. In places, the surface layer is silty clay. In places, carbonates are below a depth of 35 inches. In places, sand to loamy fine sand is below a depth of 40 inches.

Included with this soil in mapping are small areas of Labu, Lynch, and Trent soils. The Labu and Lynch soils are on higher positions and have bedded shale at a depth of 20 to 40 inches. Trent soils are on uplands and contain less clay. Included soils make up 10 to 15 percent of this map unit.

Permeability of this Verdel soil is slow. The available water capacity is moderate. The organic matter is moderate, and natural fertility is medium. The soil is slightly acid or neutral in the surface layer and neutral through moderately alkaline in the subsoil and underlying material. Runoff is slow. The water intake rate is very low. The fine texture of this soil causes it to release water slowly to plants, making it somewhat droughty. The surface layer becomes compacted if worked or trampled when wet. This soil is difficult to work and keep in good tilth.

Most of the acreage of this soil is cultivated, and some of it is irrigated. A few small narrow areas near drainageways are in native grass and are used as rangeland.

Under dryland farming, this soil is suited to small grains, corn, sorghum, soybeans, and alfalfa. Small grains and alfalfa are best suited because they grow and mature in spring when rainfall is highest. Grain sorghum is better suited than corn. Conserving soil moisture and maintaining good tilth and a high level of fertility are the main concerns of management. Stubble mulch tillage and returning crop residue to the soil increase the organic matter content and help to conserve moisture. Keeping the soil covered with crops or crop residue controls soil blowing and water erosion.

Under irrigation, this soil is suited to corn, soybeans, sorghum, alfalfa, small grains, and introduced grasses. The very low water intake rate makes slow applications of irrigation water necessary. Water application rates need to be adjusted to correspond to the water intake rate of the soil. Gravity and sprinkler irrigation systems are suited to this soil. Land leveling can be needed to produce smooth fields for gravity irrigation. In places, diversion terraces are needed to intercept runoff from adjacent areas of steeper soils. Planting deep-rooted crops and returning crop residue to the soil help to increase the intake rate and improve the organic matter content. Addition of barnyard manure increases the organic matter content and improves fertility.

This soil is suited to rangeland. This use is effective in controlling erosion. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve the range condition.

This soil is poorly suited to trees and shrubs planted in windbreaks. Capability for survival and growth of adapted species is fair. Proper site preparation and timely cultivation increase seedling survival. Because this soil is high in clay content, it is somewhat droughty for newly planted seedlings. The soil needs to be worked when it is moist but not wet. Moisture competition from weeds and undesirable grasses is the principal hazard. Weeds and grasses can be controlled by cultivation or with appropriate herbicides. Selection of drought-tolerant trees and shrubs is also needed. Irrigation can provide additional water during periods of low rainfall.

Septic tank absorption fields are not suited to this soil because of the slow permeability. A suitable alternate site is needed. This soil is generally suited to sewage lagoons. Digging is best done when the soil is not too wet. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for low strength. Coarser grained material for subgrade or base material can be used to ensure better performance. The base material for roads and streets can be mixed with additives, such as hydrated lime, to help prevent shrinking and swelling.

This Verdel soil is in capability units IIs-2 dryland and IIs-1 irrigated. It is in the Clayey range site and windbreak suitability group 4C.

Ws—Wewela fine sandy loam, 0 to 2 percent slopes. This nearly level, well drained soil formed in loamy, windblown material over shaly clay on uplands. It is moderately deep over dark shale. Individual areas range from 5 to 650 acres.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 8 inches thick. The subsoil is about 18 inches thick. It is light olive brown, friable sandy clay loam in the upper part and light brownish gray and light yellowish brown, firm clay in the lower part. The underlying material, about 12 inches thick, is light yellowish brown and brownish yellow, calcareous shaly clay. Light yellowish brown and yellow bedded shale is at a depth of about 38 inches. In places, the surface layer is loamy fine sand or fine sand. In places, this soil is dark to a depth of more than 10 inches. In places, loamy and sandy material ranges up to 30 inches thick over the clayey material. In a few places, the shale is below a depth of 40 inches.

Included with this soil in mapping are small areas of Anselmo, Dunday, Ipage, Labu, Simeon, and Valentine soils. Anselmo, Dunday, Simeon, and Valentine soils have sandier texture and lack shale within a depth of 40 inches. They are normally higher on the landscape. Labu soils are lower on the landscape and have a clayey surface layer. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Wewela soil is moderate in the loamy upper part and slow in the underlying clayey material. The available water capacity is low. The organic matter content is moderately low, and fertility is low. Runoff is slow. The soil is slightly acid or neutral in the upper part and neutral to moderately alkaline in the lower part. This soil is droughty. The water intake rate is moderately high. The soil takes in water readily but releases it slowly to plants. Tilth is generally good, and this soil is easily tilled.

Most of the acreage of this soil is used for cultivated crops. The remainder is in native grass and is used as rangeland.

Under dryland farming, this soil is suited to corn, sorghum, small grains, soybeans, alfalfa, and introduced grasses. Small grains and alfalfa are better suited because they grow and mature in spring when rainfall is highest. Sorghum is better suited than corn. Inadequate seasonal rainfall limits crop growth in most years. Soil blowing is a problem. Row crops need to be limited in the cropping system. Plowing under grasses and deep-rooted legumes for green manure increases the organic matter content and fertility. Stripcropping and keeping crop residue at the surface reduce soil blowing and help to conserve moisture. Adding barnyard manure to the soil increases the organic matter content and improves fertility.

Under irrigation, this soil is suited to corn, sorghum, soybeans, alfalfa, and introduced grasses. Gravity and sprinkler irrigation systems are suited to this soil. Some land grading may be needed for gravity irrigation. Care should be taken to avoid deep cuts that will expose the clayey material. Tillage operations that leave crop residue at the surface reduce soil erosion and improve the water intake rate. Turning under grasses and deep-rooted legumes for green manure increases the organic matter content. Adding barnyard manure to the soil improves fertility and increases the organic matter content and available water capacity.

This soil is suited to rangeland. This use is effective in controlling soil blowing. Overgrazing by livestock reduces the protective cover and causes deterioration of the potential native plants. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve the range condition.

This soil is poorly suited to trees and shrubs planted in windbreaks. Growth of trees on this soil may be poor because of the high clay content, and the choice of species is limited to those that are drought-tolerant. Irrigation can provide supplemental water during periods of insufficient moisture. Weeds and undesirable grasses can be controlled by cultivating between the rows. Areas in the row can be treated with appropriate herbicides or cultivated by hand.

Septic tank absorption fields are not suited to this soil because of slow permeability. A suitable alternate site is needed. Sewage lagoons can be constructed on areas of this soil if, after excavation, the bottom of the lagoon is sealed to prevent seepage. Digging is best done when the soil is moist but not wet. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarse grained material for subgrade or base material can be used to ensure better performance. The base material for roads and streets can be mixed with additives, such as hydrated lime, to help prevent shrinking and swelling.

This Wewela soil is in capability units IIIe-3 dryland and IIIe-7 irrigated. It is in the Sandy range site and windbreak suitability group 4C.

WsC—Wewela fine sandy loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on uplands. It is moderately deep over shale. Individual areas range from 5 to 100 acres.

Typically, the surface layer is dark grayish brown, very friable fine sandy loam about 8 inches thick. The subsoil is about 14 inches thick. It is brown, friable sandy clay loam in the upper part and light olive brown, calcareous,

firm clay in the lower part. The underlying material, about 10 inches thick, is light brownish gray and brownish yellow, calcareous shaly clay. Light brownish gray and brownish yellow bedded shale is at a depth of about 32 inches. In places, the surface layer is sandy clay loam, loam, or loamy fine sand. In a few places where this soil is near areas of sandhills, the surface layer is fine sand. In places, the loamy and sandy material ranges to as much as 30 inches thick over the clayey material. In places, the bedded shale is below a depth of 40 inches.

Included with this soil in mapping are small areas of Anselmo, Dunday, Labu, Paka, and Valentine soils. Anselmo, Dunday, and Valentine soils are sandier and lack shale within a depth of 40 inches. These soils are on ridgetops or swales. Paka soils are higher on the landscape and have silty texture. Labu soils have a clayey surface layer and are on the side slopes and ridgetops that are eroded or were not covered by the loamy material. Included soils make up 10 to 15 percent of the map unit.

Permeability of this Wewela soil is moderate in the loamy upper part and slow in the clayey lower part. The available water capacity is low. The organic matter content is moderately low, and the natural fertility level is low. Runoff is slow to medium. The soil is slightly acid or neutral in the surface layer and subsoil and neutral to moderately alkaline in the underlying material. This soil takes in water easily, but because of the silty and clayey subsoil and clayey shale underlying material, it releases water slowly to plants. Tilth is generally good and the soil is easily tilled, except in eroded areas where the clayey textures are at the surface. In these areas, tilth is poor and the soil is difficult to work.

About 50 percent of the acreage of this soil is in cultivated cropland. The rest is in native grass and is used as rangeland.

Under dryland farming, this soil is poorly suited to corn, sorghum, small grains, alfalfa, and introduced grasses. Small grains, alfalfa, and introduced grasses are best suited. Soil blowing and water erosion are the main hazards on this soil. Use of terraces, contour farming, stripcropping, and establishing grassed waterways help to control water erosion. Row crops should be limited to about 1 year out of 4. A cropping system that includes legumes or a mixture of grasses and legumes helps to replenish the supply of organic matter, maintain fertility, and control soil blowing. Tillage operations that leave all or most of the crop residue on the surface conserve soil moisture, improve the organic matter content, and help to control soil blowing. Adding barnyard manure increases fertility.

Under irrigation, this soil is suited to corn, sorghum, and alfalfa. Tillage operations that leave crop residue at the surface reduce soil erosion and improve the water intake rate. Turning under grasses and legumes increases the organic matter content.

This soil is suited to rangeland. This use is very effective in controlling soil blowing and water erosion. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition and keep the soil in good condition.

This soil is poorly suited to trees and shrubs planted in windbreaks. Erosion and inadequate seasonal rainfall are problems. Irrigation can provide supplemental water during periods of insufficient moisture. Trees can be planted on the contour to save moisture and help prevent excessive runoff and erosion. Competition for moisture from grasses and weeds can be a problem. Cultivation with conventional equipment can be used to control undesirable grasses and weeds. Areas in the row can be treated with appropriate herbicides. Some areas may need to be rototilled or hoed by hand.

Septic tank absorption fields are not suited to this soil because of slow permeability. A suitable alternate site is needed. Sewage lagoons can be constructed on areas of this soil if, after excavation, the bottom of the lagoon is sealed to prevent seepage. Digging in this soil is best done when the soil is moist but not wet. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarse grained material for subgrade or base material can be used to ensure better performance. The base material for roads and streets can be mixed with additives, such as hydrated lime, to help prevent shrinking and swelling.

This Wewela soil is in capability units IIIe-3 dryland and IIIe-7 irrigated. It is in the Sandy range site and windbreak suitability group 4C.

Wt—Wewela loam, 0 to 2 percent slopes. This well drained, nearly level soil is on uplands. It is moderately deep over dark shale. Individual areas range from 5 to 500 acres.

Typically, the surface layer is dark grayish brown, very friable loam about 8 inches thick. The subsoil is about 20 inches thick. It is light olive brown, firm clay loam in the upper part and light brownish gray and light yellowish brown, firm clay in the lower part. The underlying material, about 9 inches thick, is light yellowish brown and light gray shaly clay. Light gray and pale yellow bedded shale is at a depth of about 37 inches. In places, the surface layer is less than 7 inches thick. In places, the surface layer is silt loam or silty clay loam. In places, the loamy material ranges to as much as 24 inches thick over the clayey material. In places, the bedded shale is below a depth of 40 inches.

Included with this soil in mapping are small areas of Anselmo, Labu, Paka, and Sansarc soils. These soils are in similar positions on the landscape. Anselmo soils have a sandier profile. Labu soils have a clayey surface layer. The Paka soils have a less clayey subsoil and formed in siltstone. Sansarc soils have shale closer to the surface. Included soils make up 5 to 10 percent of this map unit.

Permeability of this Wewela soil is moderate in the loamy upper part and slow in the clayey lower part. The available water capacity is low, and the organic matter content is moderately low. Natural fertility is low. Runoff is slow. The soil is slightly acid or neutral in the surface layer and subsoil and neutral to moderately alkaline in the underlying material. The clayey subsoil takes in water slowly and releases moisture slowly to plants. This soil is droughty. The water intake is moderate. This soil is easily tilled, and tilth is generally good.

Most of the acreage of this soil is used as cropland. The remaining acreage is in native grass and is used as rangeland.

Under dryland management, this soil is suited to corn, sorghum, alfalfa, small grains, soybeans, and introduced grasses. Small grains and alfalfa are best suited because they grow in spring when rainfall is highest. Sorghum is better suited than corn. Inadequate seasonal rainfall limits crop production in most years. A cropping system that alternates the row crops with small grains and legumes is needed. Keeping the soil covered with crop residue helps to conserve moisture and control soil blowing. Adding barnyard manure increases the organic matter content and fertility.

Under irrigation, this soil is suited to corn, sorghum, small grains, soybeans, alfalfa, and introduced grasses. Gravity or sprinkler systems are suited. Some land grading is needed for gravity irrigation. Care should be taken not to expose the clayey subsoil. The exposed clayey subsoil has poor tilth and, if cultivated, becomes hard and cloddy when dry. It is sticky when wet, and crop stands are difficult to establish in these areas. A cropping sequence that includes legumes helps to open the subsoil for easier moisture penetration. Leaving crop residue on the surface and applying barnyard manure help to maintain high fertility and increase the water intake rate.

This soil is suited to native grass used for rangeland or hayland. Overgrazing by livestock reduces the protective cover and causes deterioration of the native plants. Proper grazing use, timely deferment from grazing or haying, and a planned grazing system help to maintain or improve the range condition.

This soil is poorly suited to trees and shrubs planted in windbreaks. Drought and competition from weeds and grasses for moisture are the main problems. Inadequate moisture limits growth of trees in most years. Irrigation can provide supplemental water during dry periods. Cracking because of the high shrink-swell potential can injure roots of trees. A light cultivation and applying supplemental water will close the cracks and protect the roots. Weeds and undesirable grasses can be controlled by cultivating between the rows. Areas in the row can be treated with appropriate herbicides. Areas near the trees can be rototilled or hoed by hand.

Septic tank absorption fields are not suited to this soil because of slow permeability. A suitable alternate site is needed. Sewage lagoons can be constructed on areas of this soil if, after excavation, the bottom of the lagoon is sealed to prevent seepage. Digging in this soil is best done when soil is moist but not wet. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Roads and streets need to be designed so that the surface pavement and subbase are thick enough to compensate for the low strength of the soil. Coarse-grained material for subgrade or base material can be used to ensure better performance. The base material for roads and streets can be mixed with additives, such as hydrated lime, to help prevent shrinking and swelling.

This Wewela soil is in capability units IIc-1 dryland and IIs-2 irrigated. It is in the Silty range site and windbreak suitability group 4C.

use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land use changes.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

crops and pasture

William E. Reinch, conservation agronomist, Soil Conservation Service, helped to prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

Most of the farmland in Holt County used for cultivated crops is irrigated. According to the Nebraska Agriculture Census, about 20 percent of the acreage in farms is used as cultivated cropland. The largest acreage is in corn. Over 90 percent of the irrigated cropland in the county is corn. The potential for increased production of food is good for soils in capability classes IIc-1, IIe-1, and IIe-3 in Holt County.

dryland management

Good management practices on dryland soils are those that reduce runoff, reduce the risk of erosion, conserve moisture, and improve tilth. Many of the soils in Holt County are suitable for crop production. In places, however, the hazard of erosion is severe and needs to be reduced or corrected by suitable conservation practices.

Terraces, contour farming, grassed waterways, and conservation tillage systems that keep crop residue on the surface help to reduce water erosion, increase intake rates, reduce water runoff, and improve moisture for crops. Keeping crop residue on the surface or growing a protective plant cover reduces sealing and crusting of the soil during and after heavy rains. In winter, stubble catches drifting snow that can provide additional moisture.

Soil blowing in Holt County is a major hazard. Practices that control soil blowing are crop residue management, conservation tillage practices, contour stripcropping, and narrow field windbreaks. The overall hazard of erosion can be reduced if areas of the more productive soils are used for row crops and the steeper, more erosive soils are used for close-grown crops, such as small grains, alfalfa, or grasses for hay and pasture. Only proper use of the land can reduce the hazard for erosion in many areas.

In Holt County, insufficient rainfall is a common limiting factor for crop production. Water and wind erosion are active agents on most soils. A cropping system and

management practices that control erosion need to be planned to fit the soils in each field.

The sequence of crops grown on a field, in combination with the practices needed for the management and conservation of the soil, is known as a Resource Management system. Under dryland farming, the management practices and cropping sequence should preserve tilth and fertility, maintain plant cover that protects the soil from erosion, and control weeds, insects, and diseases. Cropland Resource Management systems vary according to the soils on which they are used. For example, a Resource Management system for Dunday loamy sand, 3 to 6 percent slopes, should include a conservation tillage system of row crop production. However, on Bazile silt loam, 2 to 6 percent slopes, terraces, contour farming, and crop residue use are needed where row crops are grown in the crop rotation to control water and wind erosion and still maintain the fertility and tilth of the soil.

The best management practices for cultivated fields to protect the soil and reduce erosion on Class II soils, such as Jansen loam, and on Class IV soils, such as Elsmere loamy fine sand, are proper use of crop residue, addition of fertilizers or feedlot manure, and good agronomic practices. On Class IVe-5 soils, such as Dunday loamy sand, 0 to 3 percent slopes, the best practices are those that allow crop residue to remain on the soil over winter and a conservation tillage system that leaves 3,000 pounds per acre of corn or sorghum residue or 1,500 pounds of small grain residue on the surface after planting the crop. On such soils as Pivot and Valentine of Classes IV and VI, the best practices are those that leave a minimum of 3,500 pounds of standing crop residue 16 inches tall on the soil over winter, contour farming, and a conservation tillage system that leaves 4,000 pounds per acre of corn or sorghum residue or 2,000 pounds per acre of small grain residue on the soil surface after planting to reduce water and wind erosion to an acceptable level.

When planting crops, soils need to be worked to prepare a seedbed, to control weeds, and to provide a favorable place for plants to grow. Excessive tillage, however, breaks down the granular structure in the surface layer that is needed for good soil tilth. Steps in the tillage process should be limited to those that are essential. Various conservation tillage practices can be used in Holt County. The no-till, till-plant, and disc or chisel and plant are practices well suited to row crops. Grasses can be established by drilling into a cover of stubble without further seedbed preparation.

All soils that are used for cultivated crops or for pasture should be tested to determine their need for additional nutrients. Under dryland farming, the kind and amount of fertilizer to be applied should be based on results of soil tests and on the moisture content of the soil when fertilizer is applied. If the subsoil is dry or rainfall is below normal, the amount of nitrogen fertilizer applied should be slightly less than the recommended amount. Nitrogen fertilizer benefits nonlegume crops on all soils. Phosphorus and zinc are needed on the more eroded soils and in cut areas after construction of terraces or diversions. Dryland soils require smaller amounts of fertilizer than irrigated soils because the plant population is generally lower. Some soils in Holt County are somewhat poorly drained because of a moderately high water table. Open drainage ditches and underground tile systems can be used to help lower the water table if suitable outlets at low elevations can be located. Where the water table cannot be lowered sufficiently for good crop growth, crops can be planted that are tolerant to wet conditions.

Herbicides can be used to control weeds. Care needs to be taken to apply the correct kind of herbicide at the proper rate to correspond with the soil conditions. The colloidal clay and humus fraction of the soil is responsible for the greater part of the chemical activity of the soil. Therefore, crop damage from herbicides is more likely to occur on the coarse and moderately coarse soils that are low in colloidal clay and on areas where the organic matter content is moderately low or low. The application rate for herbicides needs to be correspondingly lower on these soils and applied in accordance with instructions on the label. Wherever possible, field boundaries should follow soil boundaries to help provide for uniformity of soils in a field, thereby decreasing the danger of damage from herbicides.

irrigation management

According to the Nebraska Agricultural Statistics, over 85 percent of all cropland in Holt County was irrigated in 1979. Corn was grown on more than 90 percent of the irrigated cropland. Other acreage was in alfalfa.

Either furrow or sprinkler systems are suited to corn and other row crops. Alfalfa can be irrigated by border, contour ditch, corrugation, or sprinkler systems.

The cropping sequence on soils that are well suited to irrigation consists mostly of row crops. A change from corn to alfalfa and grass helps to control the plant diseases and insects that are common if the same crop is grown year after year. Dunday and Pivot loamy sands and Valentine fine sand, where used for cultivated cropland, are very vulnerable to soil blowing in Holt County. Where irrigation is developed on these soils, soil blowing can be controlled if a minimum of 3,500 pounds of standing cornstalks 16 inches tall is left until the spring crop is planted (fig. 21). Conservation practices, such as conservation tillage and crop residue use, leaves a protective cover of crop residue on the soil surface after the crop is planted. These practices help to conserve the supply of irrigation water by reducing evaporation, increasing the intake of rainfall, reducing water runoff, and controlling water and wind erosion.

If sprinkler irrigation is used, water should be applied at a rate that allows the soil to absorb the water and that

Figure 21.—Cornstalk residue on Valentine fine sand, 3 to 9 percent slopes. Keeping adequate crop residue on the surface controls soil blowing and provides a good cover to help catch drifting snow, which can provide additional moisture.

will not produce runoff. Sprinklers can be used on the more sloping soils as well as on the nearly level ones. Coarse textured soils, such as Dunday loamy sand, 3 to 6 percent slopes, are suited to sprinkler irrigation if conservation practices are applied that protect the soil from blowing. In summer, much water is lost through evaporation and because of wind drift, so that water is applied unevenly under some sprinkler irrigation systems. Watering at night, when wind velocities are usually lowest and temperatures are lower, reduces evaporation and improves distribution.

There are three general kinds of sprinkler systems. One is placed at a location and left until a specified amount of water is applied; then it is moved. Another is a moving system that revolves on a central pivot. Volume guns are single large sprinklers that are being constantly moved while applying water.

Because soil holds a limited amount of water, irrigation water or precipitation is needed at regular intervals to keep the soil moist. The application interval varies according to the crop, the soil, and the amount of moisture in the soil. The water should be applied no faster than the soil can absorb it.

Irrigated sandy soils in Holt County hold about 1 inch of available water per foot of soil depth. A soil that is 4 feet deep and planted to a crop that sends its roots to a depth of 4 feet supplies about 4 inches of available water for the crop.

For maximum efficiency, irrigation should be started when about one-half of the stored water has been used

by the plants. If a soil holds 4 inches of available water, irrigation should be started when about 2 inches have been removed by the crop. An irrigation system should be planned to replace water at the rate that will provide a stable water supply for the crop.

Irrigated soils generally produce higher yields than dryfarmed soils. Consequently, more plant nutrients, particularly nitrogen and phosphorus, are removed in harvested crops. Returning all crop residue to the soil and adding feedlot manure and commercial fertilizer help to maintain the needed plant nutrients. Most grain crops in Holt County respond to nitrogen fertilizer. Soils disturbed during land leveling, particularly if the topsoil has been removed, respond to phosphorus, zinc, and iron. The kinds and amounts of fertilizer needed for specific crops should be determined by soil tests.

The soils in Holt County that are suited to irrigation are assigned to an irrigation design group. These design groups are described in the Nebraska Irrigation Guide (*10*), which is part of the technical specifications for conservation in Nebraska. The arabic numbers in the irrigated capability unit indicate the design group to which a soil belongs.

Assistance in planning and designing an irrigation system is available through the local office of the Soil Conservation Service or the county agricultural agent.

pasture and hayland management

Areas that are in hay or pasture should be managed for maximum production. Once the pasture is established, the grasses need to be kept productive. A planned system of grazing that meets the needs of the plants and promotes uniform utilization of forage is important if high returns are expected. Most forage plants are a good source of minerals, vitamins, proteins, and other nutrients. A well managed pasture can provide a balanced ration throughout the growing season.

A mixture of adapted grasses and legumes can be grown on many kinds of soils, and with proper management the soil can return a fair profit. Grasses and legumes are compatible with grain crops in a crop rotation and have beneficial effects on soil building. Because grasses and legumes help to improve tilth, add organic matter, and reduce erosion, they are an ideal crop for use in a conservation cropping system.

Grasses and legumes that are used for pasture and hayland, either irrigated or nonirrigated, require additional plant nutrients to obtain maximum vigor and growth. The kinds and amounts of fertilizer needed should be determined by a soil test. The most commonly grown grasses for irrigated pastures are smooth brome and orchardgrass. Other grasses that are adapted to irrigation in Holt County are intermediate wheatgrass, meadow brome, and creeping foxtail. Legumes that have potential for irrigated or nonirrigated pastures are alfalfa, birdsfoot trefoil, and cicer milkvetch.

Irrigated pastures in Holt County can produce 750 to 900 pounds of beef per acre with a high level of management. Irrigated pastures are an economic alternative in choosing a resource management system for irrigated croplands. Cropland can be converted to irrigated pastureland to control erosion by changing land use.

Grasses that have potential for use as pasture without irrigation are smooth brome, intermediate wheatgrass, meadow brome, tall fescue, and orchardgrass. Some native, warm-season grasses, when planted as a single species on nonirrigated land, are compatible with cool-season pastures to extend forage quality during the grazing season. Switchgrass, indiangrass, and big bluestem are native, warm-season grasses that can be used in a planned system of grazing to provide high quality forage for grazing animals during the summer months.

yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown, that good quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. These levels are defined in the following paragraphs.

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

Class I soils have slight limitations that restrict their use.

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

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

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

Capability units are soil groups within a subclass. The soils in a capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-3 or VIe-5.

The acreage of soils in each capability class and subclass is shown in table 6. The capability classification of each map unit is given in the section "Detailed soil map units."

prime farmland

Prime farmland is one of several kinds of important farmlands defined by the U. S. Department of Agriculture. Prime farmland is of major importance in providing the Nation's short- and long-range needs for food and fiber. The supply of high quality farmland is limited, and the U. S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, need to encourage and facilitate the use of our Nation's prime farmland with wisdom and foresight.

Prime farmland, as defined by the U. S. Department of Agriculture, is the land that is best suited to producing food, feed, forage, fiber, and oilseed crops. It has the soil quality, growing season, and moisture supply needed to economically produce a sustained high yield of crops when it is treated and managed using acceptable farming methods. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland may now be in crops, pasture, woodland, or other land, but it may not be urban and built-up land or water areas. It must either be used for producing food or fiber or be available for these uses.

Prime farmland usually has an adequate and dependable supply of moisture from precipitation or irrigation. It also has favorable temperature and growing season and acceptable soil reaction. It has few or no rocks and is permeable to water and air. Prime farmland is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information on the criteria for prime farmland can be obtained from the local staff of the Soil Conservation Service.

About 123,010 acres, or nearly 8 percent, of Holt County meets the soil requirements for prime farmland. A recent trend in land use in some parts of the county has been the loss of some prime farmlands to industrial

and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and difficult to cultivate and usually less productive.

Soil map units that make up prime farmland in Holt County are shown in table 7. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps in the back of this publication. The soil qualities that affect use and management are described in the section "Soil maps for detailed planning."

Soils that have limitations—a high water table, flooding, or inadequate rainfall—can qualify for prime farmland if these limitations are overcome by such measures as drainage, flood control, or irrigation. In table 7, the measures needed to overcome the limitations, if any, are shown in parentheses after the map unit name. Onsite evaluation is necessary to see if the limitations have been overcome by corrective measures.

rangeland

Peter N. Jensen, range conservationist, Soil Conservation Service, helped to prepare this section.

Rangeland makes up approximately 75 percent of the total agricultural land in Holt County. It is throughout the county, with the greatest concentration in the sandhills, on bottom land areas south of the Elkhorn River, and in the northern part of the county in association with the Niobrara River drainageway. Rangeland is common in the Elsmere-Ipage-Loup, O'Neill-Brunswick-Paka, Els-Valentine-Ipage, and Valentine-Els soil associations.

Most of the rangeland is in the Wet Land, Wet Subirrigated, Subirrigated, Sandy Lowland, Sands, Choppy Sands, and Shallow to Gravel range sites. The rest is in the Silty, Limy Upland, Sandy, Silty Lowland, Clayey, Clayey Overflow, Saline Subirrigated, Shallow Clay, and Shallow Limy range sites. The average size of ranches in Holt County is about 6,500 acres.

The raising of livestock, mainly cow and calf herds, with calves sold in the fall as feeders, is the largest agricultural industry in the county.

The rangeland is generally grazed from late in spring to early in fall. Livestock spend the fall grazing the regrowth on the native meadows or corn aftermath on irrigated cropland. They are fed hay (native or alfalfa hay, or both) during the winter and early in spring. In addition, the native forage is commonly supplemented with protein. Some of the rangeland in Holt County has been depleted. Approximately 40 percent of the rangeland is producing less than one-half of its potential in kinds and amounts of native plants. This is largely because of livestock overuse caused by overstocking and poor livestock distribution (fig. 22). The productivity of the range can be increased by proper range management and improvement practices, such as proper grazing use, deferment or rest, planned grazing systems, range seeding or interseeding, and weed control.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 8 shows, for each soil, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as or are suited to rangeland are listed. Explanation of the column headings in table 8 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was established during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre reduced to a common percent of air-dry moisture.

Characteristic vegetation—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *composition*, the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential

Figure 22.—An area of Valentine fine sand, rolling, in the Sands range site. The fence line contrast shows overgrazing on the right. The rangeland on the left is in excellent condition.

community, the better the range condition. Range condition is an ecological rating only. It does not have a specific meaning that pertains to the present plant community in a given use.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, reduction of undesirable brush species, conservation of water, and control of water erosion and soil blowing. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

native hayland (meadows)

A considerable amount of the rangeland in Holt County is used for production of native hay. Meadows usually occur where the water table is high or within five feet of the surface (fig. 23). The meadows are usually associated with Wet Land, Wet Subirrigated, Subirrigated, Saline Subirrigated, and Sandy Lowland range sites. The dominant vegetation in meadows includes big bluestem, little bluestem, indiangrass, switchgrass, prairie cordgrass, reedgrasses, and members of the sedge family. Mowing has reduced the large population of native wildflowers.

Production from native meadows can be maintained or improved by proper haying management. In order to maintain strong plant vigor, quality, and quantity of hay

Figure 23.—A typical meadow on an area of Loup fine sandy loam, 0 to 2 percent slopes. In the fall, the haystacks are moved to stack yards where they are fed to livestock during the winter.

production, the optimum time to mow is prior to the emergence of grass seedheads. Mowing height is also important in maintaining the stand of grass and the high forage production. Meadows should not be mowed closer than 3 inches in order to maintain strong plant vigor.

Meadows should not be grazed when the soil is wet or when the water table is within 6 inches of the soil surface. This prevents the formation of small bogs or mounds that can cause difficulty in mowing during later years. Meadows can be grazed for the aftermath or regrowth after frost.

At the end of each map unit description, the soil or soils in that unit are placed in an appropriate range site according to the kind and amount of vegetation that is grown on the soil when the site is in excellent or climax condition. The interpretations for each range site in the county are in the technical guide, which is in the local office of the Soil Conservation Service. Ranchers or livestock producers can obtain technical help with range management or improvement programs from the local office of the Soil Conservation Service.

native woodland

Keith A Ticknor, forester, Soil Conservation Service, prepared this section.

Holt County has approximately 32,600 acres of forest land, covering 2.1 percent of the county. The woodland

occurs mostly along the Niobrara River, Elkhorn River, and South Fork Elkhorn River and along their major tributaries. Wooded areas also occur on the steep upland slopes along the Niobrara River and its tributaries. In addition, there are some block plantings of jack pine and numerous tree claim plantings of eastern cottonwood, boxelder, black willow, and common hackberry.

Trees and shrubs in the drainageways and along the rivers consist primarily of eastern cottonwood, black willow, green ash, boxelder, American elm, Russian-olive, Siberian elm, eastern redcedar, redosier dogwood, and common chokecherry. The steep upland slopes along the Niobrara River consist mostly of bur oak, honeylocust, Russian mulberry, boxelder, eastern redcedar, hackberry, green ash, American plum, western snowberry, smooth sumac, and common chokecherry.

Many of the trees, especially eastern cottonwood, bur oak, and green ash, have commercial value for wood products. However, very few wooded areas are managed for commercial production. Most of the wooded areas are in private ownership and occupy only a small acreage of each farm unit.

Since 1955, the woodland acreage in Holt County has declined approximately 13 percent. Most of this decline has occurred as the result of clearing woodland and converting it to cropland.

Bottom land soils along the rivers and drainageways have potential for production of sawtimber, firewood, Christmas trees, and other wood products, but most of these soils are used as cropland or rangeland and are unlikely to be converted to production of wood products. Odd areas or small irregular fields are good sites for wood production.

windbreaks and environmental plantings

Keith A. Ticknor, forester, Soil Conservation Service, helped to prepare this section.

Most farmsteads and ranch headquarters in Holt County have trees around them that have been planted at various times by the landowners. Siberian elm and eastern cottonwood are the most common trees, especially in the older windbreaks. Other species, such as eastern redcedar, hackberry, green ash, ponderosa pine, jack pine, and honeylocust, are being planted in the windbreaks.

Tree plantings around the farmstead are a continuing process because old trees pass maturity and deteriorate, some trees are lost to insects and disease, others are destroyed by storms, and new windbreaks are needed for expanding farmsteads.

Field windbreaks, or shelterbelts, are numerous in Holt County, especially on bottom lands and tablelands. Many of these field windbreaks consist of eight to ten rows of trees and shrubs planted under the Prairie States Tree Planting program in the 1930's and 1940's. In addition, numerous plantings are being made in the field corners of center-pivot irrigated fields (fig. 24).

The common species in the old shelterbelts are Siberian peashrub, American plum, Russian mulberry, Russian-olive, boxelder, eastern redcedar, ponderosa pine, eastern cottonwood, Siberian and American elms, green ash, honeylocust, bur oak, and hackberry.

Many of the old field windbreaks have reached maturity, and they are deteriorating. Renovation practices of thinning, removal, and replanting are needed to maintain the value and effectiveness of these windbreaks.

In order for windbreaks to fulfill their intended purpose, the species of trees or shrubs selected must be adapted to the soils in the area to be planted. Matching the proper trees with the soil type is the first step toward ensuring survival and ensuring a maximum rate of growth. Permeability, available water capacity, fertility, soil texture, soil depth, and drainage are soil characteristics that greatly affect the rate of growth of trees and shrubs in windbreaks.

Trees and shrubs are somewhat difficult to establish in Holt County because of dry conditions and competition from other vegetation. Proper site preparation before planting and controlling weed and grass competition after planting, are important concerns in establishing and managing windbreaks. Supplemental watering is necessary for providing moisture when needed during establishment, and replacing dead trees is essential for at least two years following the initial planting.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 9 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 9 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens.

Figure 24.—An aerial view of field and farmstead windbreaks in the corners of center-pivot irrigated fields on O'Neill fine sandy loam, 0 to 2 percent slopes.

Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

recreation

Robert O. Koerner, biologist, Soil Conservation Service, helped to prepare this section.

Eleven kinds of recreation in Holt County were evaluated and appraised by representatives of county, state, and federal agencies as well as local private organizations (*9*). Rated as having high potential were vacation cabins, cottages and homesites, camping grounds, natural scenic and historic areas, and vacation farms and ranches. Rated as having medium potential were fishing water, golf courses, and hunting areas. Receiving a low rating for potential were picnic and field sports areas, riding stables, shooting preserves, and water sports areas.

The Nebraska Game and Parks Commission maintains three areas in Holt County. Atkinson Lake, near Atkinson, is a state recreation area that has a 14-acre lake and 40 acres of land surrounding it. Picnicking and camping facilities are available. Unsupervised swimming is permitted. Hunting for upland game, waterfowl, turkey, and deer is possible during season. Goose Lake, a wildlife management area in the southeast part of the county, has a 300-acre lake and 49 acres of land. Camping, fishing, boating, and hunting for waterfowl, upland game birds, and big game is possible during

regular seasons. Other activities include hiking, birdwatching, and photography. Spencer Dam Wildlife Management Area is a 9-acre tract adjacent to the Niobrara River below the Spencer Dam in northern Holt County. Picknicking and camping with minimum basic facilities are possible. River access for canoes is provided. Hunting for upland game and big game is possible during established seasons. Hunting for pheasant, quail, cottontail rabbit, squirrel, deer, mourning dove, and turkey is possible during regular designated seasons.

Swan Lake, 22 miles south of Atkinson, is a 250-acre natural sandhill lake. Adjacent to the lake is a large wooded area consisting of jack pine trees. Several private recreation facilities are available and are listed in 'Appraisals of Potentials for Outdoor Recreation Developments' (*9*). Opportunities for fishing of catfish, bass, and bluegills are available in farm ponds and the Niobrara River.

Holt County offers a wide variety of scenic attractions. The beautiful hills, valleys, and the Niobrara River and adjacent woody draws offer scenic beauty the year round.

Technical assistance is available for designing installations to improve habitat for wildlife and facilities for recreation within Holt County. The Soil Conservation Service has a field office in O'Neill and can provide this assistance, or the staff can provide the names of appropriate agencies that can give the needed assistance.

The soils of the survey area are rated in table 10 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 10, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 10 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 13 and interpretations for dwellings without basements and for local roads and streets in table 12.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

wildlife habitat

Robert O. Koerner, biologist, Soil Conservation Service, helped to prepare this section.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate

vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 11, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, and oats.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are bromegrass, clover, intermediate wheatgrass, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are big bluestem, little bluestem, goldenrod, western wheatgrass, and blue grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are green ash, hackberry, bur oak, honeylocust, Siberian elm, and eastern cottonwood. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, American plum, and common chokecherry.

Coniferous plants furnish browse, seeds, and cones. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are ponderosa pine, eastern redcedar, and jack pine.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are Siberian peashrub, cotoneaster, and skunkbush sumac.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, reed canarygrass, prairie cordgrass, rushes, sedges, and reedgrasses.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, ring-necked pheasant, meadowlark, field sparrow, cottontail, and skunk.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, bobwhite quail, thrushes, woodpeckers, squirrels, raccoon, deer, and songbirds.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, shore birds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to

rangeland include badger, deer, prairie grouse, meadowlark, and lark bunting.

The Lex-Cass-Lute and the Elsmere-Ipage-Loup associations are on bottom lands and have a high water table. The native hayland provides habitat for many shore birds and waterfowl where the water is exposed on the surface, such as along road ditches and in depressional areas (fig. 25). Portions of the area are in irrigated corn. Other parts are best suited to native grassland because of the wet conditions. Some areas of woodland are adjacent to the streams. Woodland species, such as cottonwood, willow, boxelder, and Russian-olive, provide shelter for squirrels, songbirds, and white-tailed deer. Many long field windbreaks of cottonwood and willow provide cover for white-tailed deer, pheasants, and bobwhite quail.

The Dunday-Pivot-Dunn, the Jansen-O'Neill, the Dunday-Valentine-Boelus, the Bazile-Trent, and the Paka-Anselmo associations provide habitat for openland wildlife, such as pheasants and bobwhite quail. Center-pivot irrigation systems are common. The corners in many cases are planted to trees or grasses, adding to the diversity of cover types. The irrigation systems

Figure 25.—Area of Marlake fine sandy loam, 0 to 2 percent slopes, showing one of the small lakes that are often in areas of Marlake soils.

provide water; the cornfields provide food; and the corners, borders, and woodland areas along drainageways provide food and cover for wildlife.

Tree windbreaks containing honeylocust, elm, green ash, bur oak, cottonwood, redcedar, mulberry, hackberry, Russian-olive, boxelder, caragana, and pine are in the fields and around farmsteads. These give food and winter protection for white-tailed deer, pheasant, and bobwhite quail. Cottontail rabbit and squirrels, which are also plentiful, provide hunting opportunities. During periods when pheasant and quail populations are low, the hunting of rabbits and squirrels increases.

In some cases trees that are removed for center pivots are placed in large piles. These woodpiles provide perches for predatory hawks and owls. They also provide homes and cover for cottontail rabbits, pheasants, bobwhite quail, squirrels, skunks, raccoons, opossums, and coyote.

The deeper and larger depressional areas are ponded long enough in the spring to provide resting areas for migrating waterfowl and shore birds.

The O'Neill-Brunswick-Paka and the O'Neill-Meadin-Jansen associations are associated with openland wildlife species, such as pheasant and bobwhite quail. The dissected drainageways contain woody and herbaceous vegetation that provides food, escape, and loafing cover, as well as winter protection to many species of wildlife, including songbirds, squirrels, cottontail rabbits, and mourning doves. Wild turkeys are in the heavily wooded areas near the Niobrara River. The areas that are still in native grass have prairie grouse and other upland game birds.

The Els-Valentine-Ipage, the Valentine-Els, and the Valentine-Simeon-Dunday associations sustain stands of native grasses composed of big bluestem, little bluestem, indiangrass, switchgrass, sideoats grama, and blue grama. Prairie grouse, meadowlark, lark bunting, burrowing owls, badger, skunk, coyote, white-tailed deer, and mule deer are found. Some irrigation systems have been installed and provide supplemental food and water. Several jack pine plantations have been established in the southern half of the county. These provide excellent winter cover for deer.

The Labu-Sansarc-Valentine and the Inavale-Barney-Boel associations provide the greatest diversity and contain the greatest population density and variety of wildlife. Bur oak in solid stands is in many of the side drains. Plum, coralberry, chokecherry, western snowberry, mulberry, boxelder, shagbark hickory, redcedar, Virginia creeper, poison ivy, and wild grape grow in some drainageways and provide a variety of food. Wild turkey, songbirds, bobwhite quail, pheasant, mourning dove, squirrel, and cottontail rabbit are common. The riparian habitat along the Niobrara and Elkhorn Rivers and the drainages leading into the Niobrara provide food, cover, and travel lanes for wildlife traveling to and from the water along these main water courses (fig. 26).

The Wewela-Dunday-Elşmere and the O'Neill-Anselmo-Pivot associations provide habitat for openland wildlife species, such as pheasant and bobwhite quail. Early in spring, depressions containing water provide resting and feeding areas for shore birds and waterfowl. The areas that are irrigated provide additional food for pheasants, bobwhite quail, and deer. Some depressional areas provide enough water to grow cottonwood and willow. Where these trees are present, squirrels are also common. Mourning doves are an important game bird and are found throughout the county.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

Figure 26.—Typical vegetative cover along Eagle Creek and other tributaries of the Niobrara River. This cover provides food and shelter for wild turkey, deer, and other wildlife.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

building site development

Table 12 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate*

if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

sanitary facilities

Table 13 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 13 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly

impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 13 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 13 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

construction materials

Table 14 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers

of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 14, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 15 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan,

large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 19.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

engineering index properties

Table 16 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 19.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

physical and chemical properties

Table 17 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69.

The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.
5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.
6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.
7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.
8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 17, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

soil and water features

Table 18 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes are not considered flooding.

Table 18 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months;

November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 18 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 18.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A perched water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

physical and chemical analysis of the soils

Samples from soil profiles were collected for physical and chemical analysis by the Soil Conservation Service, Soil Survey Laboratory in Lincoln, Nebraska. Soils of the Dunday, Els, Elsmere, Ipage, Jansen, Josburg, Loup, Lute, Marlake, Meadin, O'Neill, Ord, Pivot, Selia, Tryon, and Whitelake series were sampled in Holt County. Soils of the Bristow, Els, Elsmere, Ipage, Labu, Loup, Lynch, Paka, Sansarc, Tryon, Valentine, and Verdel series were sampled in adjoining counties. These data are available at the Soil Survey Laboratory. Data of the Anselmo, Cass, Nora, and Valentine soils are recorded in Soil Survey Investigations Report Number 5 (*8*).

This information is useful to soil scientists in classifying soils and developing concepts of soil genesis. It is helpful in estimating available water capacity, susceptibility to soil blowing, fertility, tilth, and other aspects of soil management.

engineering index test data

Table 19 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are typical of the series and are described in the section "Soil series and their morphology." The soil samples were tested by the State of Nebraska, Department of Roads.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are: AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); Particle density (T-100-75l).

The group index number that is part of the AASHTO classification was computed using the Nebraska modification system.

classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*11*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 20, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Ustoll (*Ust*, meaning intermittently dry, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplustolls (*Hapl*, meaning minimal horizonation, plus *ustoll*, the suborder of the Mollisols that have an ustic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haplustolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is coarse-loamy, mixed, mesic Typic Haplustolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

soil series and their morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (*7*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*11*). Unless otherwise stated, matrix colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

Anselmo series

The Anselmo series consists of deep, well drained soils on uplands and stream terraces. Permeability is moderately rapid. These soils formed in loamy and sandy eolian material. Slope ranges from 0 to 6 percent.

Anselmo soils are adjacent to Cass, Dunday, Jansen, Josburg, O'Neill, and Paka soils. Cass soils are on bottom lands and are more stratified in the solum. Dunday soils are sandier throughout and are higher on the landscape. Jansen and O'Neill soils have gravelly coarse sand at a depth of 20 to 40 inches and are

normally lower on the landscape. Josburg and Paka soils have more clay in the subsoil and are lower on the landscape.

Typical pedon of Anselmo fine sandy loam, 0 to 2 percent slopes, 1,300 feet south and 900 feet west of the northeast corner of sec. 25, T. 25 N., R. 9 W.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; medium acid; abrupt smooth boundary.

A12—7 to 15 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium and fine granular structure; soft, very friable; medium acid; clear wavy boundary.

B2—15 to 29 inches; brown (10YR 5/3) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak medium and fine subangular blocky structure; soft, very friable; medium acid; clear wavy boundary.

C—29 to 60 inches; pale brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) moist; weak coarse prismatic structure; soft, very friable; medium acid.

Thickness of the solum ranges from 16 to 38 inches. Thickness of the mollic epipedon ranges from 7 to 20 inches. The soil is medium acid through neutral.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is fine sandy loam, sandy loam, or loam. The B2 horizon has value of 4 through 6 (3 or 4 moist) and chroma of 2 or 3. It is fine sandy loam or sandy loam. The C horizon has value of 5 through 7 (4 through 6 moist) and chroma of 2 through 4. It is fine sandy loam, loamy fine sand, fine sand, or sand.

Barney series

The Barney series consists of poorly drained, rapidly permeable soils on low flood plains along major drainageways. These soils formed in a thin layer of stratified, silty and sandy alluvium. Slope ranges from 0 to 2 percent.

Barney soils are adjacent to Boel, Inavale, and Marlake soils. Boel, Inavale, and Marlake soils all lack coarse sand within a depth of 40 inches. Boel soils are somewhat poorly drained and are higher on the landscape. Inavale soils are on the highest bottom land positions and are somewhat excessively drained. Marlake soils are lower on the landscape and are very poorly drained.

Typical pedon of Barney silt loam, channeled, 1,900 feet east and 700 feet north of the southwest corner of sec. 26, T. 33 N., R. 12 W.

A1—0 to 8 inches; gray (10YR 5/1) silt loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, very friable; few thin strata of loamy fine sand and light yellowish brown (10YR 6/4) sand; neutral; clear smooth boundary.

C1—8 to 16 inches; light gray (10YR 7/2) fine sand, grayish brown (10YR 5/2) moist; common fine faint yellowish brown (10YR 5/4) mottles; single grained; loose; common thin strata of fine sandy loam and loamy fine sand; slight effervescence; moderately alkaline; gradual wavy boundary.

IIC2—16 to 60 inches; white (10YR 8/2) coarse sand, light brownish gray (10YR 6/2) moist; single grained; loose; 12 percent by volume gravel; many thin strata of fine sand in the upper part; mildly alkaline.

Thickness of the solum and depth of the mollic colors range from 7 to 10 inches. Depth to the IIC horizon ranges from 7 to 20 inches. Depth to carbonates ranges from 0 to 10 inches, but some pedons do not have free carbonates.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silt loam, but the range includes silty clay loam or fine sandy loam that is finely stratified with coarser material. The A horizon ranges from neutral to moderately alkaline. The C horizon has hue of 10YR, value of 5 through 7 (4 or 5 moist), and chroma of 1 or 2. It is loamy fine sand or fine sand that is finely stratified with finer and coarser material. Faint to distinct, brownish and grayish mottles are in the C horizon. The C horizon is mildly alkaline or moderately alkaline. The IIC horizon has hue of 10YR, value of 6 through 8 (5 through 7 moist), and chroma of 1 or 2. The IIC horizon is dominantly coarse sand and less commonly fine sand or sand. It is 5 to 15 percent gravel by volume. The IIC horizon is neutral or mildly alkaline.

Bazile series

The Bazile series consists of deep, well drained soils on uplands and stream terraces. Permeability is moderately slow in the upper part and rapid in the lower part. These soils formed in loess or silty material over outwash sands. Slope ranges from 0 to 6 percent.

Bazile soils are adjacent to Fillmore, Jansen, and Trent soils. Fillmore soils have more clay in the subsoil and are in depressional areas. Jansen soils have more sand in the subsoil and are underlain by gravelly coarse sand. Trent soils have a mollic epipedon that is more than 20 inches thick and formed in loess or silty sediment. Jansen and Trent soils are in similar positions on the landscape as Bazile soils.

Typical pedon of Bazile silt loam, 0 to 2 percent slopes, 800 feet north and 200 feet west of the southeast corner of sec. 26, T. 29 N., R. 9 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium and fine granular structure; slightly hard, friable; strongly acid; abrupt smooth boundary.

A12—6 to 11 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium and fine granular structure; slightly hard, friable; medium acid; clear smooth boundary.
B21t—11 to 18 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; weak medium and fine subangular blocky structure; slightly hard, friable; medium acid; clear smooth boundary.
B22t—18 to 24 inches; yellowish brown (10YR 5/4) silty clay loam, dark yellowish brown (10YR 4/4) moist; weak medium and coarse subangular blocky structure parting to weak medium and fine subangular blocky; slightly hard, friable; neutral; clear smooth boundary.
B3—24 to 31 inches; light yellowish brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) moist; weak medium and fine subangular blocky structure; slightly hard, friable; neutral; clear smooth boundary.
IIC—31 to 60 inches; very pale brown (10YR 7/3) sand, pale brown (10YR 6/3) moist; loose; mildly alkaline.

Thickness of the solum and the depth to the sand range from 20 to 40 inches.

The A horizon has hue of 10YR, value of 3 through 5 (2 or 3 moist), and chroma of 2. It is dominantly silt loam, but the range includes light silty clay loam, loam, or fine sandy loam. The A horizon is medium acid or slightly acid. The B horizon has hue of 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 through 4. It is silty clay loam or silt loam. The B horizon ranges from medium acid to mildly alkaline. In some pedons, the B horizon has strata of loam or clay loam in the lower part. The IIC horizon has hue of 10YR, value of 6 through 8 (5 or 6 moist), and chroma of 2 through 4. It is sand or coarse sand and less commonly loamy fine sand or fine sand. Thin layers of gravel are in some pedons. The IIC horizon ranges from slightly acid to mildly alkaline.

Boel series

The Boel series consists of deep, somewhat poorly drained, rapidly permeable soils that formed in sandy alluvium on bottom lands. Slope ranges from 0 to 2 percent.

Boel soils are commonly near Els, Elsmere, Inavale, Loup, and Tryon soils. Elsmere and Els soils are in similar landscape positions and are less stratified. Inavale soils are higher on the landscape and are somewhat excessively drained. Loup and Tryon soils are slightly lower on the landscape and are poorly drained or very poorly drained.

Typical pedon of Boel loamy fine sand, 0 to 2 percent slopes, 2,300 feet east and 1,900 feet north of the southwest corner of sec. 23, T. 29 N., R. 13 W.

A1—0 to 11 inches; dark gray (10YR 4/1) loamy fine sand, very dark gray (10YR 3/1) moist; weak medium and fine granular structure; soft, very friable; slight effervescence; moderately alkaline; clear smooth boundary.
AC—11 to 17 inches; grayish brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak coarse and medium subangular blocky structure; soft, very friable; slight effervescence; moderately alkaline; clear smooth boundary.
C1—17 to 28 inches; light brownish gray (10YR 6/2) fine sand, grayish brown (10YR 5/2) moist; few medium distinct dark yellowish brown (10YR 4/4 moist) mottles; single grained; loose; few thin strata of loamy fine sand; mildly alkaline; clear smooth boundary.
C2—28 to 60 inches; white (10YR 8/2) fine sand, light gray (10YR 7/2) moist; few medium distinct yellow (10YR 7/6 moist) mottles; single grained; loose; few thin strata of loamy fine sand; mildly alkaline.

The mollic epipedon and solum range from 10 to 20 inches in thickness. Carbonates are typically in the A horizon and are lacking in some of the lower horizons. The soil is neutral to moderately alkaline.

The A horizon has value of 3 through 5 (2 or 3 moist) and chroma of 1 or 2. It is loamy fine sand, fine sandy loam, or silty clay loam. The color and texture of the AC horizon range between those of the A and C horizons. The C horizon has value of 6 through 8 (5 through 7 moist) and chroma of 2 or 3. It is coarse sand or fine sand. The C horizon has brownish, reddish, or yellowish mottles. Typically, the C horizon is stratified with lighter and darker material, which can be coarser or finer textured.

Boelus series

The Boelus series consists of deep, well drained soils formed in eolian sands deposited over loamy sediment (fig. 27). Permeability is rapid in the upper part and moderate in the underlying material. These soils are on uplands and stream terraces. Slope ranges from 0 to 11 percent.

The Boelus soils in Holt County are in a drier climate than is typical for the Boelus series. This difference, however, does not affect the use or behavior of the soils.

Boelus soils are commonly near Anselmo, Dunday, Dunn, Meadin, Paka, Pivot, and Valentine soils. Anselmo soils are lower on the landscape and contain less sand in the upper part of the profile. Dunday and Valentine soils are higher on the landscape and are sandy throughout. Dunn soils are in similar landscape positions and are moderately well drained. Meadin soils are higher on the landscape and have gravelly coarse sand at a depth of 8 to 20 inches. Paka soils are in similar positions and contain more clay in the upper part. Pivot

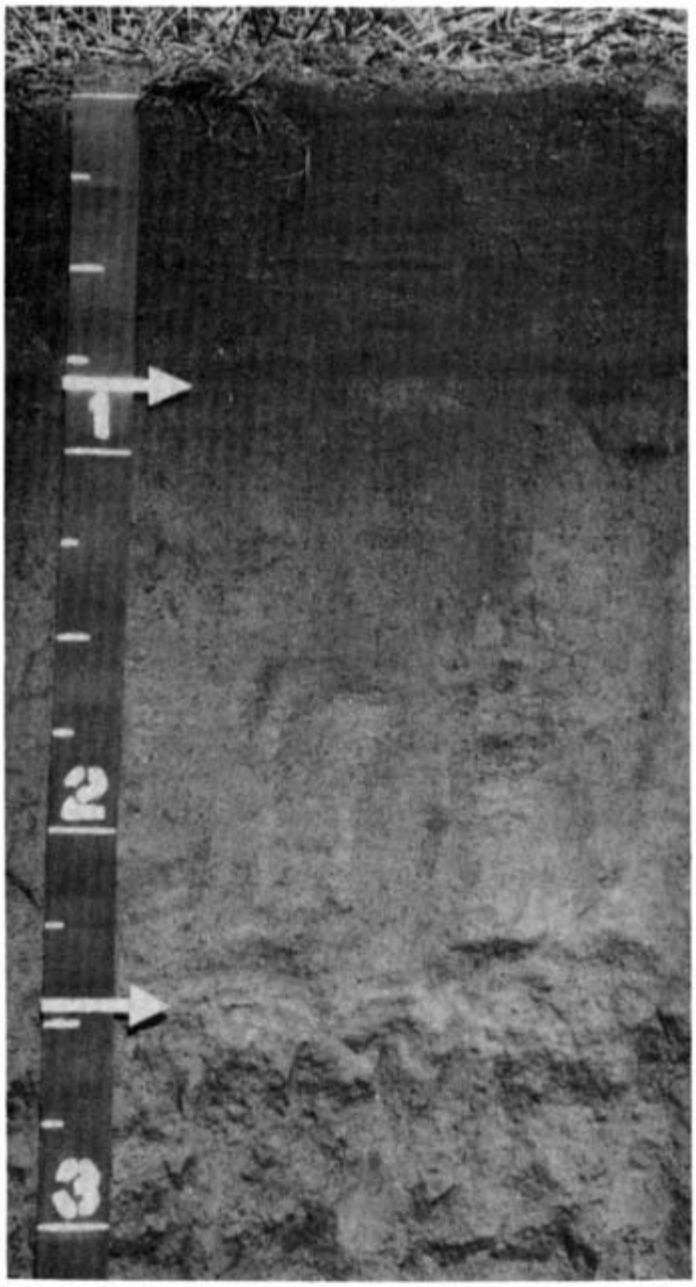


Figure 27.—Profile of Boelus soil. The top arrow marks the lower boundary of the surface layer. The bottom arrow marks the contact between the sandy material and the underlying material. The scale is in feet.

soils are in similar positions and have gravelly coarse sand at a depth of 20 to 40 inches.

Typical pedon of Boelus loamy sand, 0 to 3 percent slopes, 2,400 feet south and 100 feet west of the northeast corner of sec. 6, T. 30 N., R. 9 W.

A11—0 to 12 inches; dark grayish brown (10YR 4/2) loamy sand, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable; slightly acid; clear smooth boundary.

A12—12 to 17 inches; grayish brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure parting to weak medium and fine granular; soft, very friable; slightly acid; gradual smooth boundary.

A3—17 to 26 inches; brown (10YR 5/3) sand, dark brown (10YR 4/3) moist; single grained; loose; neutral; few fine pebbles; abrupt wavy boundary.

IIB2—26 to 36 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 4/3) moist; rust stains; weak coarse and medium subangular blocky structure; slightly hard, friable; neutral; gradual wavy boundary.

IIC—36 to 60 inches; light yellowish brown (10YR 6/4) silty clay loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable; neutral.

Thickness of the mollic epipedon ranges from 10 to 20 inches. Depth to the loamy IIB horizon ranges from 20 to 36 inches. Solum thickness ranges from 24 to 40 inches. Some pedons have a C horizon above the IIB horizon. The solum ranges from slightly acid to moderately alkaline.

The A1 horizon has value of 4 to 5 (2 through 3 moist) and chroma of 1 or 2. It is dominantly loamy sand, but the range includes loamy fine sand. The A3 horizon has value of 5 or 6 (4 or 5 moist) and chroma of 2 through 4. It is loamy sand or sand. The IIB and IIC horizons have hue of 10YR, 2.5Y, or 5Y; value of 5 through 7 (4 through 6 moist); and chroma of 2 through 4. These horizons are very fine sandy loam, loam, silt loam, or silty clay loam. In some pedons, the IIC horizon contains carbonates. The IIC horizon is neutral to moderately alkaline.

Bristow series

The Bristow series consists of shallow, well drained, slowly permeable soils on residual uplands. These soils formed in light colored, calcareous soft shales. Slope ranges from 20 to 40 percent.

Bristow soils are near Labu, Lynch, and Sansarc soils. Labu and Lynch soils are 20 to 40 inches thick over bedded shale. Labu soils are higher on the landscape. Lynch soils are lower on the landscape. Sansarc soils are in similar positions on the landscape, formed in darker shale, and contain less calcium carbonate.

Typical pedon of Bristow silty clay, 20 to 40 percent slopes, 1,130 feet south and 150 feet east of the northwest corner of sec. 12, T. 32 N., R. 10 W.

A1—0 to 6 inches; pale brown (10YR 6/3) silty clay, brown (10YR 5/3) moist; weak fine granular structure; hard, friable; strong effervescence; mildly alkaline; gradual smooth boundary.

C—6 to 16 inches; very pale brown (10YR 8/3 and 10YR 7/4) shaly clay, pale brown (10YR 6/3) and yellowish brown (10YR 5/4) moist; weak medium and thin platy structure; hard, friable; violent effervescence; 20 percent by volume shale fragments; 25 percent calcium carbonate equivalent; moderately alkaline; gradual wavy boundary.
Cr—16 to 60 inches; pale yellow (2.5Y 8/4) bedded shale, light yellowish brown (2.5Y 6/4) moist; coarse and very coarse platy shale fragments; violent effervescence; moderately alkaline.

Thickness of the solum ranges from 5 to 10 inches. Depth to shale is 5 to 20 inches. The solum is mildly alkaline or moderately alkaline, and the calcium carbonate equivalent ranges from 15 to 25 percent. The content of carbonate-free clay ranges from 38 to 55 percent in the control section.

The A horizon has hue of 10YR or 2.5Y, value of 4 through 6 (3 through 5 moist), and chroma of 3 or 4. It is dominantly silty clay and less commonly silty clay loam or clay. The C and Cr horizons have hue of 10YR and 2.5Y, value of 6 through 8 (4 through 6 moist), and chroma of 3 or 4. Calcium carbonates and gypsum are common in the seams and fractures.

Brunswick series

The Brunswick series consists of moderately deep, well drained soils on uplands. Permeability is moderately rapid. These soils formed in residuum weathered from weakly cemented sandstone bedrock (fig. 28). Slope ranges from 9 to 30 percent.

The Brunswick soils in Holt County are in a drier climate than is typical for the Brunswick series. This difference, however, does not affect the use or behavior of the soils.

Brunswick soils are adjacent to Anselmo, Meadin, O'Neill, Paka, Pivot, and Tassel soils. Anselmo soils are lower on the landscape and do not have underlying cemented sandstone. Meadin soils are higher on the landscape and have gravelly coarse sand at a depth of 8 to 20 inches. O'Neill soils are higher on the landscape and have gravelly coarse sand at a depth of 20 to 40 inches. Paka soils are lower on the landscape and have more clay throughout. O'Neill and Paka soils are normally on gentler slopes. Pivot soils are in similar positions on the landscape and have a sandy texture. Tassel soils are higher on the landscape and have soft sandstone at a depth of 10 to 20 inches.

Typical pedon of Brunswick fine sandy loam, from an area of Brunswick-Tassel fine sandy loams, 11 to 40 percent slopes, 2,250 feet south and 300 feet west of the northeast corner of sec. 35, T. 31 N., R. 13 W.

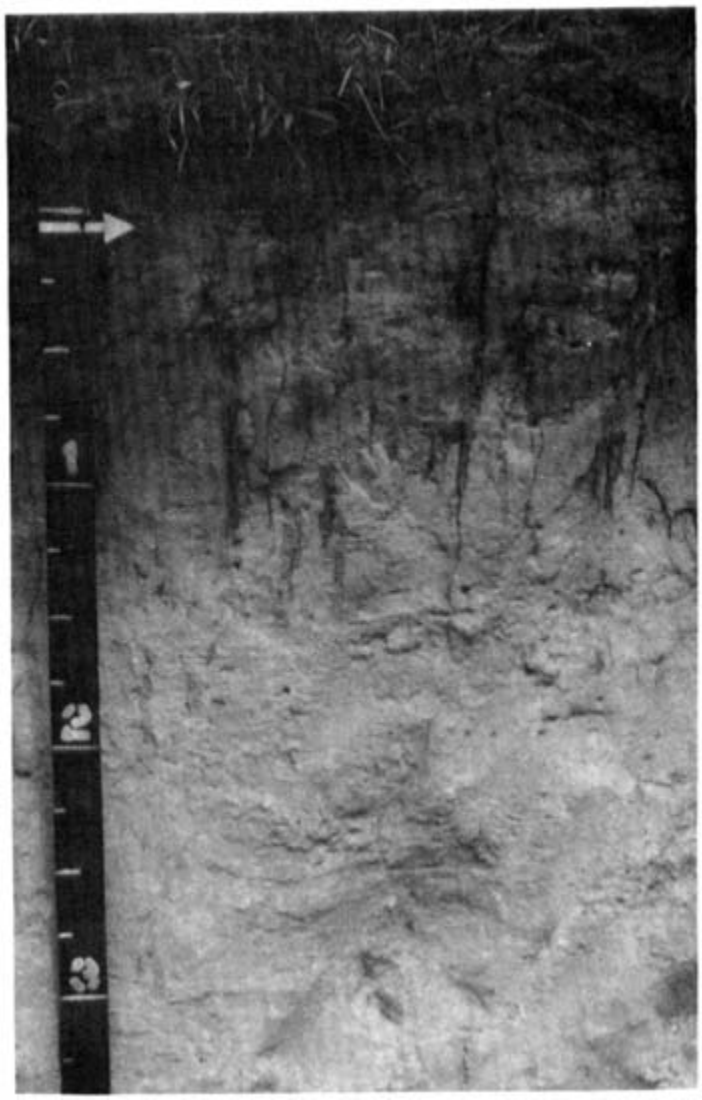


Figure 28.—Profile of Brunswick fine sandy loam. This soil is moderately deep and formed in residuum weathered from soft sandstone bedrock. The arrow marks the lower boundary of the surface layer. The scale is in feet.

A1—0 to 4 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; slightly acid; clear smooth boundary.
B2—4 to 12 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak medium and fine subangular blocky structure; soft, very friable; slightly acid; gradual smooth boundary.
B3—12 to 16 inches; light brownish gray (2.5Y 6/2) fine sandy loam, grayish brown (2.5Y 5/2) moist; weak coarse and medium subangular blocky structure; soft, very friable; slightly acid; gradual smooth boundary.

C—16 to 24 inches; light gray (2.5Y 7/2) loamy fine sand, light brownish gray (2.5Y 6/2) moist; single grained; loose; few small soft sandstone fragments; neutral; gradual wavy boundary.
Cr—24 to 60 inches; white (5Y 8/2) weakly cemented sandstone that crushes to fine sand, pale yellow (5Y 7/3) moist; neutral.

Thickness of the solum ranges from 12 to 28 inches. Depth to soft sandstone bedrock ranges from 20 to 40 inches.

The A horizon has value of 4 through 6 (3 or 4 moist) and chroma of 1 or 2. The A horizon ranges from 4 to 12 inches in thickness. Horizons having value of less than 5.5 dry or 3.5 moist are less than 7 inches thick. The A horizon is dominantly fine sandy loam, but the range includes loam or loamy fine sand. It is medium acid or slightly acid. The B horizon has hue of 10YR or 2.5Y, value of 5 through 7 (4 or 5 moist), and chroma of 2 or 3. It is typically fine sandy loam but includes loam averaging less than 18 percent clay. The B horizon is medium acid or slightly acid. The C horizon has hue of 10YR, 2.5Y, or 5Y; value of 6 through 8 (5 through 7 moist); and chroma of 2 or 3. It ranges from loamy fine sand to fine sand. The C horizon is slightly acid or neutral. The Cr horizon has colors similar to those of the C horizon.

Cass series

The Cass series consists of deep, well drained soils that formed in mixed alluvium on bottom lands. Permeability is moderately rapid in the solum and rapid in the underlying material. Slope ranges from 0 to 2 percent.

Cass soils are commonly adjacent to Dunday, Inavale, Nimbro, and Ord soils. Dunday and Inavale soils are sandy and occupy higher positions on the landscape. Nimbro soils are finer textured and occupy slightly lower positions on the landscape. Ord soils are lower on the landscape and are somewhat poorly drained.

Typical pedon of Cass fine sandy loam, 0 to 2 percent slopes, 1,056 feet west and 50 feet north of the southeast corner of sec. 34, T. 30 N., R. 15 W.

Ap—0 to 5 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium and fine granular structure; slightly hard, very friable; slightly acid; abrupt smooth boundary.
A12—5 to 12 inches; dark gray (10YR 4/1) fine sandy loam, very dark brown (10YR 2/2) moist; weak medium and coarse subangular blocky structure; slightly hard, very friable; neutral; clear smooth boundary.
A13—12 to 18 inches; dark gray (10YR 4/1) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure parting to weak medium and fine subangular blocky; slightly hard, very friable; neutral; clear smooth boundary.
AC—18 to 30 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak coarse and medium subangular blocky structure; slightly hard, very friable; few thin strata of loamy fine sand; neutral; gradual smooth boundary.
C1—30 to 36 inches; light brownish gray (10YR 6/2) loamy fine sand, brown (10YR 5/3) moist; single grained; loose; few thin strata of fine sandy loam; mildly alkaline; gradual smooth boundary.
C2—36 to 60 inches; very pale brown (10YR 7/3) fine sand, pale brown (10YR 6/3) moist; loose; mildly alkaline.

Thickness of the solum ranges from 20 to 32 inches. Thickness of the mollic epipedon ranges from 10 to 20 inches. In some pedons, free carbonates are below a depth of 30 inches.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is dominantly fine sandy loam, but the range includes silt loam, loam, or very fine sandy loam. The A horizon ranges from medium acid to neutral. The C horizon has value of 5 through 7 (4 through 6 moist) and chroma of 2 or 3. It is fine sandy loam, sandy loam, or loamy fine sand in the upper part and fine sand in the lower part. Strata of coarser and finer material are common. The C horizon ranges from slightly acid to mildly alkaline. Strata of coarse sand and gravel are common below a depth of 40 inches.

Dunday series

The Dunday series consists of deep, somewhat excessively drained, rapidly permeable soils. These soils formed in eolian sands on uplands and stream terraces. Slope ranges from 0 to 6 percent.

Dunday soils are commonly adjacent to Anselmo, Boelus, Dunn, Pivot, Valentine, and Wewela soils. Anselmo soils contain more clay in the subsoil and are lower on the landscape. Boelus and Pivot soils are in similar positions on the landscape. Boelus soils have loamy underlying material. Pivot soils are underlain by gravelly coarse sand at a depth of 20 to 40 inches. Valentine soils are higher on the landscape and do not have a mollic epipedon. Wewela soils are lower on the landscape and have a loamy and clayey subsoil.

Typical pedon of Dunday loamy sand, 0 to 3 percent slopes, 2,150 feet north and 400 feet west of the southeast corner of sec. 16, T. 28 N., R. 10 W.

A11—0 to 7 inches; dark gray (10YR 4/1) loamy sand, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable; slightly acid; clear smooth boundary.

A12—7 to 17 inches; dark grayish brown (10YR 4/2) loamy sand, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to weak medium and fine subangular blocky; soft, very friable; slightly acid; clear wavy boundary.
AC—17 to 28 inches; brown (10YR 5/3) sand, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure parting to weak medium subangular blocky; soft, very friable; slightly acid; gradual wavy boundary.
C1—28 to 46 inches; pale brown (10YR 6/3) fine sand, brown (10YR 5/3) moist; weak coarse prismatic structure; soft, very friable; slightly acid; clear wavy boundary.
C2—46 to 60 inches; very pale brown (10YR 7/3) fine sand, pale brown (10YR 6/3) moist; single grained; loose; slightly acid.

Thickness of the solum ranges from 14 to 30 inches. Thickness of the mollic epipedon ranges from 10 to 20 inches. The soil is slightly acid or neutral.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is loamy sand and loamy fine sand. The AC horizon has value of 4 through 6 (3 or 4 moist) and chroma of 2 or 3. The C horizon has value of 5 through 7 (4 through 6 moist) and chroma of 2 through 4. It is fine sand, loamy fine sand, loamy sand, and sand. Buried loamy or silty layers are in some profiles below a depth of 40 inches.

Dunn series

The Dunn series consists of deep, moderately well drained soils that formed in eolian sand underlain by loamy alluvium. Permeability is rapid in the upper part of the profile and slow in the lower part. These soils are on uplands and stream terraces. Slope ranges from 0 to 3 percent.

Dunn soils are commonly adjacent to Boelus, Dunday, O'Neill, Pivot, and Valentine soils. Boelus, Dunday, O'Neill, and Pivot soils are in similar positions on the landscape. Boelus soils are well drained. Dunday soils are sandy throughout. O'Neill and Pivot soils have gravelly coarse sand at a depth of 20 to 40 inches. Valentine soils are higher on the landscape, do not have a mollic epipedon, and are sandy throughout.

Typical pedon of Dunn loamy sand, 0 to 3 percent slopes, 1,300 feet east and 50 feet north of the southwest corner of sec. 2, T. 29 N., R. 13 W.

A1—0 to 12 inches; dark grayish brown (10YR 4/2) loamy sand, very dark gray (10YR 3/1) moist; weak fine and medium granular structure; soft, very friable; medium acid; clear smooth boundary.
AC—12 to 17 inches; grayish brown (10YR 5/2) sand, very dark grayish brown (10YR 3/2) moist; weak fine and medium granular structure; soft, very friable; medium acid; gradual smooth boundary.
C1—17 to 28 inches; pale brown (10YR 6/3) sand, brown (10YR 5/3) moist; common medium faint yellowish brown (10YR 5/6 moist) mottles; single grained; loose; medium acid; abrupt smooth boundary.
IIB2b—28 to 42 inches; light brownish gray (10YR 6/2) sandy clay loam, grayish brown (10YR 5/2) moist; common medium faint brownish yellow (10YR 6/6 moist) mottles; moderate coarse prismatic structure parting to strong medium and coarse angular blocky; very hard, firm; common pressure faces; many fine roots and dark, sandy material in cracks and cleavages; slightly acid; gradual smooth boundary.
IIC2—42 to 60 inches; light gray (2.5Y 7/2) sandy clay loam, light brownish gray (2.5Y 6/2) moist; many coarse faint brownish yellow (10YR 6/6 moist) mottles; moderate coarse prismatic structure; very hard, firm; many fine roots and dark, sandy material in cracks and cleavages; mildly alkaline.

Thickness of the mollic epipedon ranges from 10 to 20 inches. Depth to carbonates ranges from 20 to 60 inches or more. Depth to the IIB2 horizon ranges from 20 to 37 inches.

The A horizon has value of 3 through 5 (2 through 3 moist) and chroma of 1 through 3. It is dominantly loamy sand, but the range includes loamy fine sand. The A horizon ranges from 10 to 14 inches in thickness. It is medium acid through neutral. The C horizon has value of 5 through 7 (4 through 6 moist) and chroma of 2 through 4. It is loamy sand, fine sand, or sand. The C horizon contains faint yellowish brown or reddish brown mottles. It is medium acid through neutral. The IIB2b horizon has hue of 10YR or 7.5YR, value of 5 through 7 (3 through 6 moist), and chroma of 2 through 4. The dominant texture is sandy clay loam, but the range includes loam and clay loam. Clay content ranges from 24 to 35 percent and averages about 30 percent. Mottles are common. The IIC horizon has hue of 5Y, 2.5Y, 7.5YR, or 10YR; value of 6 through 8 (4 through 6 moist); and chroma of 2 through 4. Textures are the same as those for the IIB2b horizon. The IIB2b and IIC horizons range from medium acid to mildly alkaline.

Els series

The Els series consists of deep, somewhat poorly drained, rapidly permeable soils that formed in mixed eolian and alluvial sand. These soils are on the bottoms of valleys in the sandhill areas. Slope ranges from 0 to 2 percent.

Els soils are similar to Elsmere soils and are commonly near Ipage, Tryon, and Valentine soils. Elsmere soils have a mollic epipedon. Ipage and Valentine soils are higher on the landscape and are better drained. Tryon soils are lower on the landscape and are poorly drained.

Typical pedon of Els loamy sand, 0 to 2 percent slopes, 900 feet east and 2,270 feet south of the northwest corner of sec. 9, T. 28 N., R. 13 W.

A1—0 to 6 inches; dark gray (10YR 4/1) loamy sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; slightly acid; clear smooth boundary.
AC—6 to 13 inches; grayish brown (10YR 5/2) fine sand, dark grayish brown (10YR 4/2) moist; few fine faint yellowish brown (10YR 5/6) mottles; single grained; loose; neutral; gradual wavy boundary.
C1—13 to 23 inches; brown (10YR 5/3) sand, dark brown (10YR 4/3) moist; few fine distinct yellowish brown (10YR 5/6 moist) mottles; single grained; loose; neutral; gradual wavy boundary.
C2—23 to 31 inches; very pale brown (10YR 7/3) sand, pale brown (10YR 6/3) moist; few fine distinct yellowish brown (10YR 5/6 moist) mottles; single grained; loose; slightly acid; gradual wavy boundary.
C3—31 to 42 inches; white (10YR 8/2) sand, light gray (10YR 7/2) moist; single grained; loose; neutral; gradual wavy boundary.
IIC4—42 to 60 inches; white (10YR 8/2) coarse sand, light gray (10YR 7/2) moist; single grained; loose; slightly acid.

Thickness of the solum ranges from 10 to 18 inches. The soil ranges from slightly acid to mildly alkaline.

The A horizon has value of 4 or 5 (3 moist) and chroma of 1 or 2. It is fine sand, loamy sand, or loamy fine sand. The A horizon ranges from 6 to 9 inches in thickness. The AC horizon has value of 5 or 6 (4 or 5 moist) and chroma of 1 through 3. Typically, it is fine sand, but some pedons are loamy sand or loamy fine sand. The C horizon has value of 5 through 8 (4 through 7 moist) and chroma of 2 or 3. Typically, it is sand, but some pedons are fine sand or loamy sand. Mottles in the C horizon are yellowish brown, strong brown, or dark reddish brown. Dark, buried horizons of loamy fine sand or fine sand about 2 to 8 inches thick commonly are between depths of 15 and 40 inches. Coarse sand or gravelly coarse sand is below a depth of 40 inches.

Elsmere series

The Elsmere series consists of deep, somewhat poorly drained, rapidly permeable soils that formed in mixed eolian and alluvial sand (fig. 29). Permeability in the clayey substratum is rapid in the upper part and slow in the lower part. These soils are on bottom lands and stream terraces. Slope ranges from 0 to 2 percent.

Elsmere soils are similar to Els soils and are commonly near Gannett, Ipage, Loup, Ord, Selia, and Wewela soils. Els soils do not have a mollic epipedon. Gannett and Loup soils are lower on the landscape and are poorly drained or very poorly drained. Ipage soils are

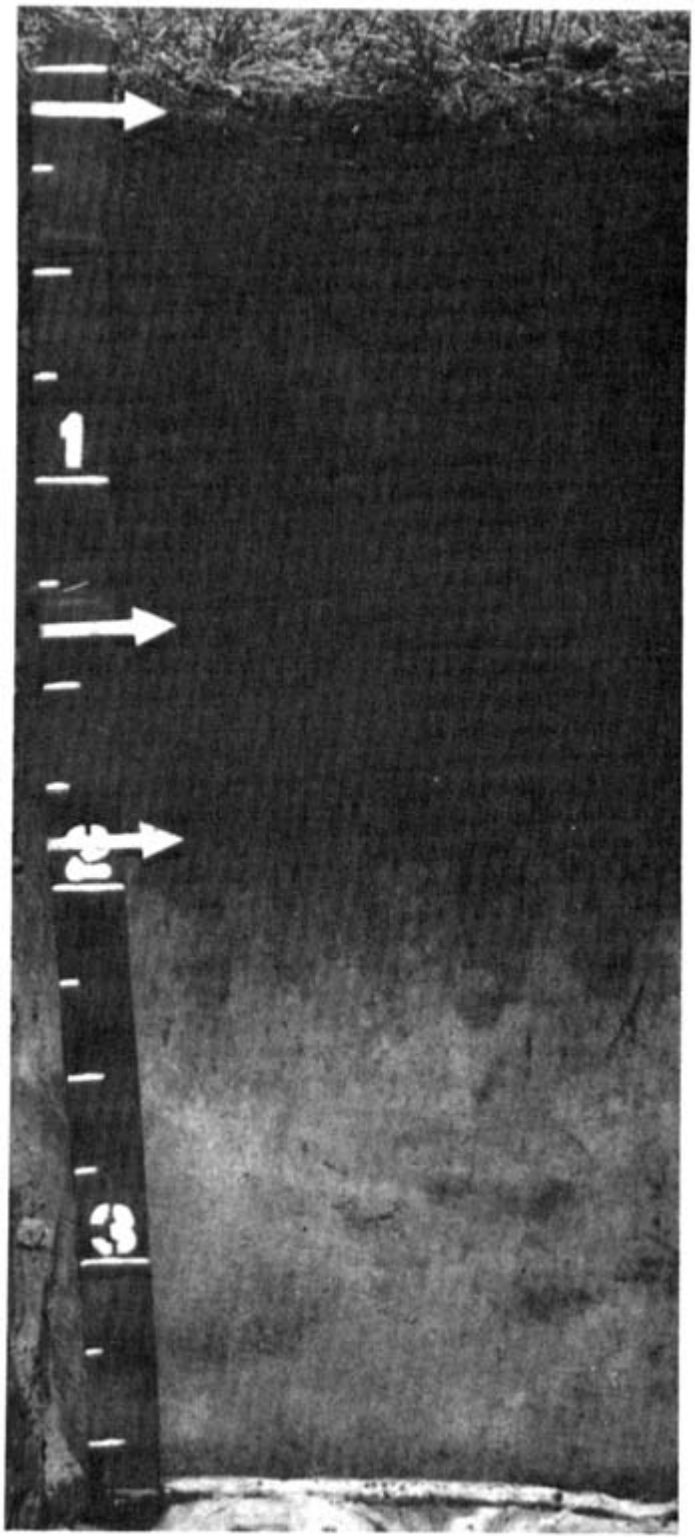


Figure 29.—Profile of Elsmere loamy fine sand. This soil has a thick, dark surface layer. The water table is at a depth of about 44 inches. The scale is in feet.

higher on the landscape and are moderately well drained. Ord and Selia soils are in similar positions on the landscape. Ord soils have more clay in the solum. Selia soils are high in sodium content.

Typical pedon of Elsmere loamy fine sand, 0 to 2 percent slopes, 1,200 feet west and 2,300 feet north of the southeast corner of sec. 8, T. 27 N., R. 13 W.

A11—0 to 4 inches; dark grayish brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; slightly acid; clear smooth boundary.
A12—4 to 9 inches; dark gray (10YR 4/1) loamy fine sand, very dark gray (10YR 3/1) moist; weak fine granular structure; soft, very friable; mildly alkaline; clear smooth boundary.
A13—9 to 18 inches; dark grayish brown (10YR 4/2) fine sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; moderately alkaline; clear smooth boundary.
AC—18 to 24 inches; brown (10YR 5/3) fine sand, dark brown (10YR 4/3) moist; few fine faint strong brown (7.5YR 5/6 moist) mottles; single grained; loose; moderately alkaline; clear wavy boundary.
C1—24 to 39 inches; very pale brown (10YR 7/3) fine sand, pale brown (10YR 6/3) moist; few medium distinct strong brown (7.5YR 5/6 moist) mottles; single grained; loose; neutral; clear wavy boundary.
C2—39 to 49 inches; gray (10YR 5/1) fine sand, dark gray (10YR 4/1) moist; many fine faint grayish brown (10YR 5/2 moist) mottles; single grained; loose; mildly alkaline; gradual wavy boundary.
C3—49 to 60 inches; light gray (10YR 7/2) fine sand, grayish brown (10YR 5/2) moist; common coarse distinct light yellowish brown (10YR 6/4 moist) mottles; single grained; loose; neutral.

Thickness of the mollic epipedon ranges from 10 to 20 inches. Thickness of the solum ranges from 16 to 36 inches. The soil is medium acid through moderately alkaline.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is fine sand, loamy sand, loamy fine sand, or fine sandy loam. The AC horizon has value of 4 through 6 (3 or 4 moist) and chroma of 1 through 3. It is fine sand, loamy sand, or loamy fine sand. The C horizon has value of 5 through 7 (4 through 6 moist) and chroma of 1 through 3. It is commonly fine sand and less commonly loamy sand or sand. Mottles in the C horizon range from few to many and are yellowish brown, strong brown, or dark reddish brown.

Fillmore series

The Fillmore series consists of deep, poorly drained soils that formed in loess. Permeability is very slow. These soils are in upland depressions that are ponded by water for short periods following heavy rains. Slope ranges from 0 to 2 percent.

Fillmore soils are adjacent to Bazile, Jansen, and Trent soils. Bazile and Jansen soils do not have an albic horizon, contain less clay in the subsoil, and have sand or gravelly coarse sand at a depth of 20 to 40 inches. Trent soils have less clay in the B horizon and do not have an albic horizon. Bazile, Jansen, and Trent soils are in higher positions on the landscape.

Typical pedon of Fillmore silt loam, 0 to 2 percent slopes, 1,400 feet north and 500 feet west of the southeast corner of sec. 35, T. 29 N., R. 9 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable; slightly acid; abrupt smooth boundary.
A12—6 to 12 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak medium and fine granular structure; soft, very friable; slightly acid; abrupt smooth boundary.
A2—12 to 16 inches; gray (10YR 6/1) silt loam, dark gray (10YR 4/1) moist; weak medium platy structure; soft, very friable; slightly acid; abrupt smooth boundary.
B21t—16 to 26 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; moderate medium prismatic structure parting to strong medium and fine blocky; very hard, very firm; mildly alkaline; gradual wavy boundary.
B22t—26 to 38 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; weak medium prismatic structure parting to moderate medium and fine angular blocky; very hard, very firm; mildly alkaline; gradual wavy boundary.
B3—38 to 50 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to weak medium subangular blocky; hard, firm; slight effervescence; moderately alkaline; gradual smooth boundary.
C—50 to 60 inches; light brownish gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; weak coarse subangular blocky structure; hard, friable; slight effervescence; moderately alkaline.

Thickness of the solum ranges from 30 to 60 inches. Depth to carbonates is about 30 to 60 inches, but some pedons lack free carbonates to a depth of more than 60 inches. Mollic color extends into the upper part of the B horizon.

The A1 horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is commonly silt loam and less commonly silty clay loam. The A1 horizon is medium acid or slightly acid. The A2 horizon has value of 5 or 6 (4 or 5 moist) and chroma of 1. Structure is platy or granular. The A2 horizon is medium acid or slightly acid.

The B2t horizon has value of 3 through 5 (2 through 4 moist) and chroma of 1 or 2. It is silty clay or silty clay loam averaging 35 to 55 percent clay. The B2t horizon is slightly acid through mildly alkaline. The IIC horizon has hue of 10YR or 2.5Y, value of 5 through 7 (4 through 6 moist), and chroma of 2 through 4. It is sandy clay loam or loam, but the range includes silty clay loam, clay loam, or silt loam. The IIC horizon is neutral through moderately alkaline.

Gannett series

The Gannett series consists of deep, poorly drained and very poorly drained soils on bottom lands. These soils formed in loamy and sandy alluvium. Permeability is moderately rapid in the solum and rapid in the underlying material. Slope ranges from 0 to 2 percent.

Gannett soils are most commonly near Elsmere, Lamo, Lawet, Lex, Loup, Marlake, and Ord soils. Elsmere soils are higher on the landscape and are better drained. Lamo, Lawet, Lex, and Ord soils are slightly higher on the landscape and are somewhat poorly drained. Loup soils are in similar positions on the landscape and are sandy. Marlake soils are sandy and in the lowest positions on the landscape. They are covered with water much of the year.

Typical pedon of Gannett loam, 0 to 2 percent slopes, 2,500 feet north and 300 feet east of the southwest corner of sec. 21, T. 26 N., R. 11 W.

A11—0 to 5 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak fine granular; slightly hard, very friable; mildly alkaline; strong effervescence; abrupt smooth boundary.

A12—5 to 8 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak coarse subangular blocky structure parting to weak medium granular; slightly hard, very friable; mildly alkaline; strong effervescence; gradual smooth boundary.

A13—8 to 21 inches; dark gray (10YR 4/1) loam stratified with thin lenses of fine sandy loam and sandy clay loam, black (10YR 2/1) moist; weak coarse subangular blocky structure parting to moderate medium and fine subangular blocky; slightly hard, very friable; mildly alkaline; gradual smooth boundary.

C—21 to 60 inches; light gray (10YR 7/1) fine sand stratified with thin lenses of loamy fine sand and silt loam, gray (10YR 6/1) moist; few coarse distinct yellowish brown (10YR 5/6 moist) mottles; single grained; loose; mildly alkaline.

Thickness of the solum ranges from 18 to 24 inches; it commonly is the same as the thickness of the mollic epipedon. Typically, carbonates are near the surface, but in some places the solum is noncalcareous. The soil is mildly alkaline or moderately alkaline.

The A horizon has value of 3 through 5 (2 or 3 moist) and chroma of 1 or 2. Typically, it is loam, but the range includes fine sandy loam. The A horizon ranges from 16 to 27 inches in thickness. The C horizon has value of 6 through 8 (5 through 7 moist) and chroma of 1 or 2. Typically, it is fine sand.

Inavale series

The Inavale series consists of deep, somewhat excessively drained, rapidly permeable soils on bottom lands. These soils formed in sandy alluvium. Slope ranges from 0 to 2 percent.

Inavale soils are similar to Ipage soils and are near Barney, Boel, Cass, Loup, and Tryon soils. Ipage soils are not stratified and have mottles within a depth of 40 inches. Barney, Loup, and Tryon soils are lower on the landscape and are poorly drained. Boel soils have a mollic epipedon and are somewhat poorly drained. Cass soils are in similar positions on the landscape and have more clay in the solum.

Typical pedon of Inavale loamy fine sand, 0 to 2 percent slopes, 400 feet north and 380 feet east of the southwest corner of sec. 9, T. 26 N., R. 10 W.

A1—0 to 5 inches; dark grayish brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; slightly acid; clear wavy boundary.

AC—5 to 21 inches; grayish brown (10YR 5/2) fine sand, dark grayish brown (10YR 4/2) moist; single grained; loose; slightly acid; gradual smooth boundary.

C—21 to 60 inches; light gray (10YR 7/2) fine sand, light brownish gray (10YR 6/2) moist; few fine faint yellowish brown (10YR 5/6) moist) mottles below a depth of 42 inches; thin strata of lighter and darker fine sand and sandy loam; single grained; loose; slightly acid.

Thickness of the solum ranges from 10 to 25 inches. The soil is slightly acid or neutral.

The A horizon has value of 4 or 5 (3 or 4 moist) and chroma of 1 or 2. It ranges from 5 to 9 inches in thickness. The A horizon is loamy fine sand, loamy sand, fine sand, or sand. The C horizon has value of 5 through 7 (4 through 6 moist) and chroma of 2 or 3. Typically, it is fine sand, but the range includes loamy fine sand, loamy sand, or sand. Strata of finer textured material are common in the C horizon.

In map unit Ia (Inavale sand, channeled), the underlying material contains more gravel than is typical for the range of the series. This difference does not alter the usefulness or behavior of the soil.

Ipage series

The Ipage series consists of deep, moderately well drained, rapidly permeable soils that formed in eolian

and alluvial sands. These soils are on low, hummocky slopes or low ridges in sandhill valleys and along stream terraces. Slope ranges from 0 to 3 percent.

Ipage soils are commonly near Els, Elsmere, Libory, Tryon, Valentine, and Wewela soils. Els and Elsmere soils are lower on the landscape and are somewhat poorly drained. Elsmere soils have a mollic epipedon. Libory soils are in similar positions on the landscape and have loamy underlying material. Tryon soils are on the lowest parts of the landscape and are poorly drained and very poorly drained. Valentine soils are higher on the landscape and do not have mottles within a depth of 40 inches. Wewela soils are higher in the landscape and have a loamy and clayey subsoil.

Typical pedon of Ipage sand, from an area of Els-Ipage complex, 0 to 3 percent slopes, 1,000 feet south and 225 feet east of the northwest corner of sec. 9, T. 28 N., R. 13 W.

A1—0 to 5 inches; dark grayish brown (10YR 4/2) sand, very dark grayish brown (10YR 3/2) moist; weak medium and fine granular structure; soft, very friable; medium acid; clear smooth boundary.

AC—5 to 11 inches; grayish brown (10YR 5/2) sand, dark grayish brown (10YR 4/2) moist; single grained; loose; medium acid; gradual wavy boundary.

C1—11 to 21 inches; pale brown (10YR 6/3) sand, brown (10YR 5/3) moist; single grained; loose; medium acid; gradual wavy boundary.

C2—21 to 32 inches; very pale brown (10YR 7/3) fine sand; pale brown (10YR 6/3) moist; single grained; loose; medium acid; gradual wavy boundary.

C3—32 to 54 inches; white (10YR 8/2) fine sand, light gray (10YR 7/2) moist; common medium and fine distinct yellowish brown (10YR 5/6) mottles; single grained; loose; medium acid; gradual smooth boundary.

IIC4—54 to 60 inches; light gray (10YR 7/2) coarse sand, light brownish gray (10YR 6/2) moist; single grained; loose; 5 percent by volume gravel; medium acid.

Thickness of the solum ranges from 3 to 21 inches. The soil ranges from medium acid to neutral.

The A horizon has value of 4 through 6 (3 or 4 moist) and chroma of 1 or 2. It is sand, fine sand, loamy sand, or loamy fine sand. Thickness of the A horizon ranges from 3 to 10 inches. The AC horizon has value of 5 or 6 (4 or 5 moist) and chroma of 2 or 3. It is sand, fine sand, or loamy sand.

The C horizon has value of 6 or 7 (4 through 6 moist) and chroma of 2 or 3. It has few to common, distinct and prominent mottles to a depth of 40 inches. Mottles are yellowish brown, strong brown, or dark reddish brown. The C horizon is commonly fine sand and less commonly sand or loamy sand. Coarse sand or gravelly coarse sand is common below a depth of 40 inches. Loamy layers are below a depth of 40 inches in some pedons.

Jansen series

The Jansen series consists of well drained soils on uplands. Permeability is moderate in the solum and very rapid in the underlying material. These soils formed mainly in loamy material overlying gravelly coarse sand. Slope ranges from 0 to 6 percent.

Jansen soils are commonly adjacent to Anselmo, Bazile, Josburg, Meadin, O'Neill, and Paka soils. Anselmo soils are higher on the landscape and have a coarser textured subsoil. Bazile, Josburg, O'Neill, and Paka soils are in similar positions on the landscape. Bazile soils have underlying material that is sand. Josburg soils have loamy underlying material. O'Neill soils have more sand in the subsoil. Paka soils are loamy and silty throughout the profile. Meadin soils are lower on the landscape and have gravelly coarse sand between depths of 8 and 20 inches.

Typical pedon of Jansen loam, 0 to 2 percent slopes, 2,000 feet south and 100 feet west of the northeast corner of sec. 6, T. 29 N., R. 11 W.

Ap—0 to 6 inches; dark gray (10YR 4/1) loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure parting to weak medium and fine granular; slightly hard, very friable; strongly acid; abrupt smooth boundary.

A12—6 to 12 inches; dark gray (10YR 4/1) loam, very dark brown (10YR 2/2) moist; weak coarse blocky structure parting to weak fine subangular blocky; slightly hard, friable; medium acid; clear smooth boundary.

B1—12 to 15 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate coarse blocky structure parting to moderate medium and fine subangular blocky; slightly hard, friable; slightly acid; clear smooth boundary.

B21t—15 to 18 inches; brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard, firm; slightly acid; clear smooth boundary.

B22t—18 to 25 inches; brown (10YR 5/3) sandy clay loam, dark yellowish brown (10YR 3/4) moist; moderate coarse prismatic structure parting to moderate medium and fine subangular blocky; hard, firm; medium acid; clear wavy boundary.

IIB3—25 to 30 inches; light yellowish brown (10YR 6/4) loamy coarse sand, yellowish brown (10YR 5/4) moist; very weak medium and fine subangular blocky structure parting to single grained; soft, very friable; medium acid; gradual wavy boundary.

IIC1—30 to 60 inches; very pale brown (10YR 7/4) gravelly coarse sand, yellowish brown (10YR 5/4) moist; single grained; loose; slightly acid.

Solum thickness and depth to gravelly coarse sand range from 20 to 36 inches. Gravel is on the surface and mixed throughout the profile of some pedons. The mollic epipedon ranges from 7 to 20 inches in thickness and may extend into the B horizon. The profile is strongly acid to neutral throughout.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is dominantly loam, but the range includes sandy loam and silt loam. Thickness of the A horizon ranges from 8 to 15 inches. The B2t horizon has value of 4 through 6 (3 through 5 moist) and chroma of 2 through 4. It is loam, clay loam, or sandy clay loam that averages between 18 and 32 percent clay. The IIC horizon has value of 5 through 7 (4 through 6 moist) and chroma of 3 or 4. Gravel content in the gravelly sand typically ranges from 15 to 35 percent by volume.

Josburg series

The Josburg series consists of deep, moderately well drained soils that formed in loamy alluvial sediment. These soils are on uplands. Permeability is moderate in the upper part of the profile and slow in the lower part. Slope ranges from 0 to 2 percent.

Josburg soils are adjacent to Anselmo, Dunn, Jansen, O'Neill, and Paka soils. Anselmo soils are higher on the landscape and contain more sand. Dunn, Jansen, O'Neill, and Paka soils are in similar landscape positions. Dunn soils contain more sand in the upper part of the profile. Jansen and O'Neill soils have gravelly coarse sand at a depth of 20 to 40 inches. Paka soils contain less sand and have moderate permeability throughout the profile.

Typical pedon of Josburg loam, 0 to 2 percent slopes, 1,900 feet west and 200 feet north of the southeast corner of sec. 26, T. 30 N., R. 13 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) loam, very dark gray (10YR 3/1) moist; weak fine granular structure; soft, very friable; medium acid; abrupt smooth boundary.

A12—7 to 13 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium and fine granular structure; soft, very friable; medium acid; few fine pebbles; clear smooth boundary.

B1—13 to 16 inches; grayish brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) moist; moderate medium and fine subangular blocky structure; slightly hard, friable; slightly acid; 3 percent fine pebbles; clear smooth boundary.

B21—16 to 24 inches; brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) moist; weak coarse subangular blocky structure parting to moderate medium subangular blocky; hard, friable; slightly acid; 5 percent fine pebbles; clear smooth boundary.

IIB22—24 to 32 inches; yellowish brown (10YR 5/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist; moderate coarse prismatic structure parting to strong medium angular blocky; very hard, firm; 2 percent fine pebbles; dark soil material in cleavages between prisms; slightly acid; clear smooth boundary.

IIB3—32 to 42 inches; pale brown (10YR 6/3) sandy clay loam, brown (10YR 5/3) moist; moderate medium and coarse prismatic structure; very hard, firm; dark soil material and plant roots concentrated in cleavages between prisms; neutral; clear smooth boundary.

IIC1—42 to 48 inches; very pale brown (10YR 7/3) sandy clay loam, pale brown (10YR 6/3) moist; many coarse faint light yellowish brown (10YR 6/4 moist) mottles; weak coarse prismatic structure; hard, friable; dark soil material and plant roots concentrated in cleavages between prisms; few calcium carbonate accumulations; strong effervescence; moderately alkaline; gradual wavy boundary.

IIC2—48 to 60 inches; very pale brown (10YR 8/3) fine sandy loam, very pale brown (10YR 7/3) moist; many coarse faint very pale brown (10YR 7/4 moist) mottles; weak coarse prismatic structure; slightly hard, very friable; few calcium carbonate concretions; strong effervescence; moderately alkaline.

The solum ranges from 36 to 53 inches in thickness. The mollic epipedon ranges from 10 to 20 inches in thickness. Calcium carbonates are below a depth of 30 inches. Many pedons do not have free carbonates to a depth of 60 inches. Fine pebbles are on the surface and mixed throughout the solum.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 through 3. It is sandy loam, fine sandy loam, loam, or silt loam. The A horizon is very strongly acid through medium acid.

The B2 and IIB2 horizon has hue of 7.5YR or 10YR, value of 4 through 6 (3 through 5 moist), and chroma of 2 through 4. It is loam, clay loam, or sandy clay loam. The horizon is strongly acid through slightly acid. Dark buried layers are in some pedons.

The IIC horizon has hue of 7.5YR, 10YR, or 2.5Y; value of 6 through 8 (5 through 7 moist); and chroma of 2 through 4. It is fine sandy loam, clay loam, sandy loam, or sandy clay loam. In places, carbonates occur as small accumulations of soft powdery lime in a noncalcareous matrix. The IIC horizon is slightly acid through moderately alkaline.

Labu series

The Labu series consists of moderately deep, well drained, slowly permeable soils on uplands. These soils formed in residuum weathered from dark clay shales (fig. 30). Slope ranges from 2 to 30 percent.

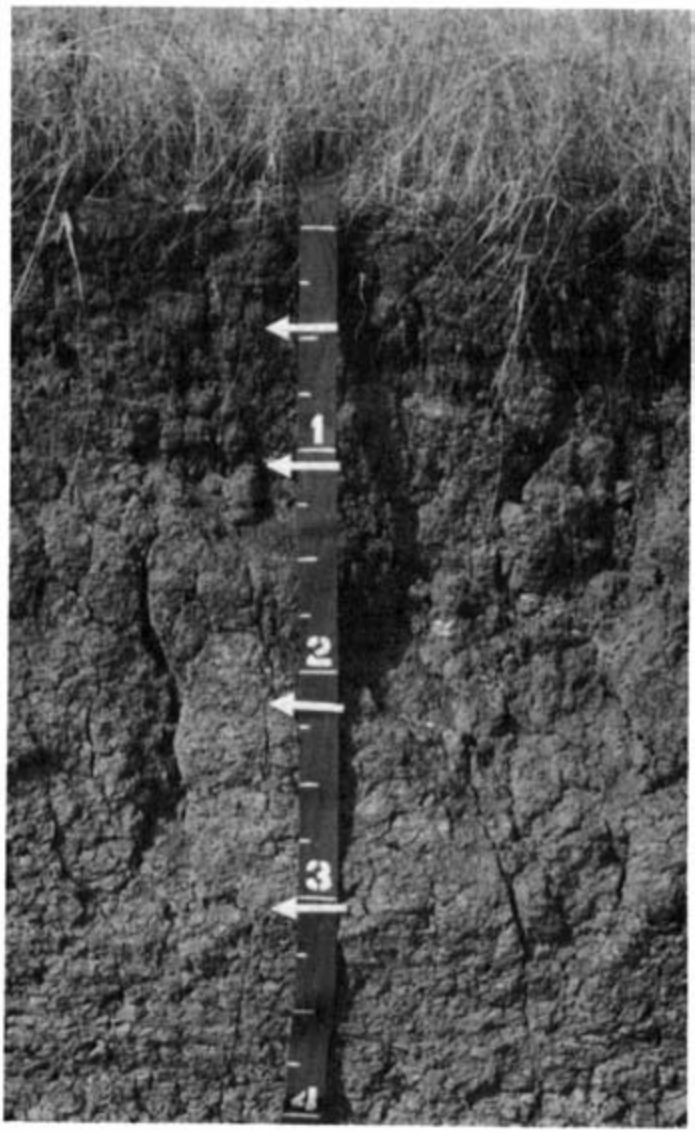


Figure 30.—Profile of Labu silty clay. This clayey soil developed in residuum weathered from shale. The bottom arrow marks the upper boundary of the bedded shale. The scale is in feet.

Labu soils are similar to Lynch soils and are commonly adjacent to Paka, Sansarc, Verdel, and Wewela soils. Lynch soils are lower on the landscape and formed in the light colored shales. Paka soils are higher on the landscape and formed from siltstone sediment. Wewela soils are higher on the landscape and have a mollic epipedon and a loamy A horizon. Verdel soils are lower on the landscape and have a mollic epipedon.

Typical pedon of Labu silty clay, from an area of Labu-Sansarc silty clays, 11 to 30 percent slopes, 800 feet north and 700 feet west of the southeast corner of sec. 24, T. 32 N., R. 12 W.

A1—0 to 5 inches; dark grayish brown (2.5Y 4/2) silty clay, very dark grayish brown (2.5Y 3/2) moist; moderate medium and fine granular structure; hard, firm; neutral; clear smooth boundary.

B21—5 to 12 inches; light olive brown (2.5Y 5/4) silty clay, olive brown (2.5Y 4/4) moist; weak coarse prismatic structure parting to moderate medium and fine subangular blocky; hard, firm; mildly alkaline; clear smooth boundary.

B22—12 to 20 inches; light olive brown (2.5Y 5/4) silty clay, olive brown (2.5Y 4/4) moist; weak coarse prismatic structure parting to moderate coarse angular blocky; very hard, firm; strong effervescence; moderately alkaline; gradual smooth boundary.

C1—20 to 24 inches; light olive brown (2.5Y 5/4) shaly clay, olive brown (2.5Y 4/4) moist; weak coarse subangular blocky structure parting to weak medium and thin platy; very hard, firm; 16 percent shale fragments; few accumulations of lime and gypsum; violent effervescence; moderately alkaline; clear smooth boundary.

Cr—24 to 60 inches; light yellowish brown (2.5Y 6/4) bedded shale, light olive (5Y 5/4) moist; medium and thin platy shale fragments; very hard, firm; many accumulations of lime and gypsum; violent effervescence; moderately alkaline.

Thickness of the solum ranges from 20 to 28 inches. Depth to bedded shale ranges from 20 to 40 inches. The solum ranges from neutral to moderately alkaline throughout. Cracks that range up to 2 inches in width and several feet in length commonly extend through the solum when the soil is dry.

The A horizon has hue of 10YR or 2.5Y, value of 4 through 6 (3 or 4 moist), and chroma of 2 or 3. It is dominantly silty clay, but the range includes clay. The A horizon is 4 to 6 inches thick. The B horizon has hue of 10YR through 5Y, value of 5 or 6 (4 or 5 moist), and chroma of 2 through 4. It is silty clay or clay. The C horizon has hue of 10YR through 5Y, value of 5 through 7 (4 through 6 moist), and chroma of 2 through 4. It is shaly clay or clay. Some pedons contain accumulations of gypsum. The Cr horizon has hue of 10YR through 5Y, value of 6 or 7 (4 or 6 moist), and chroma of 2 through 4.

Lamo series

The Lamo series consists of deep, somewhat poorly drained soils that formed in loamy alluvium deposited

over coarse sand on bottom lands. Permeability is moderately slow. Slope ranges from 0 to 2 percent.

Lamo soils are similar to Lawet soils and are commonly adjacent to Gannett, Lex, and Lute soils. Lawet, Lex, and Lute soils are in similar landscape positions. Lawet soils contain more sand in the control section and have a calcic horizon. Lex soils contain less silt in the upper part of the control section, have coarse sand in the lower part of the control section, and have a mollic epipedon that is less than 20 inches thick. Lute soils are high in sodium content. Gannett soils are poorly drained or very poorly drained and are lower on the landscape.

Typical pedon of Lamo loam, from an area of Lamo-Lute loams, 0 to 2 percent slopes, 2,200 feet north and 40 feet east of the southwest corner of sec. 21, T. 30 N., R. 15 W.

A11—0 to 9 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak fine granular structure; soft, very friable; mildly alkaline; clear smooth boundary.

A12—9 to 20 inches; dark gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; moderate medium subangular blocky structure parting to moderate fine and very fine subangular blocky; very hard, firm; violent effervescence; moderately alkaline; clear smooth boundary.

A13—20 to 27 inches; gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; moderate coarse subangular blocky structure parting to strong medium and fine angular blocky; very hard, firm; strong effervescence; moderately alkaline; clear smooth boundary.

AC—27 to 34 inches; gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; weak coarse subangular blocky structure parting to moderate medium and coarse subangular blocky; very hard, firm; few small lime concretions and soft masses; slight effervescence; moderately alkaline; clear smooth boundary.

C1—34 to 43 inches; light brownish gray (10YR 6/2) sandy clay loam, grayish brown (10YR 5/2) moist; common medium distinct light olive brown (2.5Y 5/6 moist) mottles; massive; hard, firm; slight effervescence; moderately alkaline; clear smooth boundary.

IIC2—43 to 54 inches; light brownish gray (10YR 6/2) coarse sand, grayish brown (10YR 5/2) moist; many coarse faint brownish yellow (10YR 6/6 moist) mottles; single grained; loose; moderately alkaline; abrupt smooth boundary.

IIC3—54 to 60 inches; pale brown (10YR 6/3) coarse sand, brown (10YR 5/3) moist; many coarse faint brownish yellow (10YR 6/6 moist) mottles; single grained; loose; moderately alkaline.

Thickness of the solum and the mollic epipedon range from 24 to 36 inches. Depth to carbonates is typically less than 10 inches.

The A horizon has hue of 10YR, value of 3 through 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly loam, but the range includes silty clay loam and silt loam. The A horizon is mildly alkaline or moderately alkaline. The AC horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. The C and IIC horizons have hue of 10YR, 2.5Y, or 5Y; value of 5 through 7 (4 through 6 moist); and chroma of 1 through 3. The C horizon is silty clay loam or sandy clay loam. The C horizon in some pedons is stratified with sand to sandy clay loam. The C horizon is commonly mottled with few to many distinct mottles. The C horizon is mildly alkaline or moderately alkaline. The IIC horizon is below a depth of 4 inches and is coarse sand or sand. The IIC horizon is neutral to moderately alkaline.

Lawet series

The Lawet series consists of deep, somewhat poorly drained, moderately permeable soils on bottom lands. These soils formed in calcareous, loamy alluvium. Slope ranges from 0 to 2 percent.

Lawet soils are adjacent to Gannett, Lex, Libory, Lute, and Ord soils. Gannett soils are lower on the landscape and are poorly drained or very poorly drained. Lex, Lute, and Ord soils are in similar landscape positions. Lex soils have coarse sand in the lower part of the profile. Lute soils are high in sodium content. Ord soils contain less clay. Libory soils are higher on the landscape and have sandy over loamy texture. Ord soils contain more sand in the C horizon.

Typical pedon of Lawet loam, drained, 0 to 2 percent slopes, 475 feet east and 275 feet north of the southwest corner of sec. 35, T. 28 N., R. 11 W.

A11—0 to 8 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; moderate medium granular structure; slightly hard, very friable; strong effervescence; mildly alkaline; gradual wavy boundary.

A12ca—8 to 16 inches; gray (10YR 5/1) loam, very dark gray (10YR 3/1) moist; weak fine subangular blocky structure; slightly hard, very friable; violent effervescence; 25 percent calcium carbonate equivalent; moderately alkaline; gradual wavy boundary.

C1ca—16 to 22 inches; light brownish gray (10YR 6/2) loam, grayish brown (10YR 5/2) moist; weak fine subangular blocky structure; slightly hard, friable; violent effervescence; 20 percent calcium carbonate equivalent; moderately alkaline; gradual wavy boundary.

C2ca—22 to 44 inches; light gray (10YR 7/2) loam, light brownish gray (10YR 6/2) moist; common fine prominent reddish brown (10YR 5/4) moist) mottles; weak medium subangular blocky structure; slightly hard, friable; many soft white carbonate accumulations; violent effervescence; 30 percent calcium carbonate equivalent; moderately alkaline; gradual wavy boundary.

C3g—44 to 60 inches; light gray (2.5Y 7/2) loam, light brownish gray (2.5Y 6/2) moist; few fine distinct yellowish brown (10YR 5/6 moist) mottles; massive; slightly hard, very friable; neutral.

Thickness of the solum ranges from 16 to 30 inches. Thickness of the mollic epipedon ranges from 7 to 24 inches. The calcium carbonate equivalent ranges from 15 to 40 percent throughout the control section.

The A horizon has value of 3 through 5 (2 or 3 moist) and a chroma of 1 or 2. It is dominantly loam, but the range includes silt loam or silty clay loam. The A horizon is mildly alkaline through strongly alkaline. The C horizon has value of 6 through 8 (5 through 7 moist) and chroma of 1 or 2. It is very fine sandy loam, loam, silt loam, or sandy clay loam. Some profiles have thin strata of sandy loam or clay loam. In a few places, loamy sand or sand is below a depth of 40 inches. The C horizon is neutral through strongly alkaline.

Lex series

The Lex series consists of somewhat poorly drained soils on bottom lands. These soils are moderately deep over coarse sand or gravelly coarse sand. Permeability is moderate in the upper part and very rapid in the lower part. These soils formed in loamy alluvium deposited over coarse sand or gravelly coarse sand. Slope ranges from 0 to 2 percent.

Lex soils are commonly adjacent to Lamo, Lawet, Lute, Gannett, and Ord soils. Lamo, Lawet, Lute, and Ord soils are in similar positions on the landscape. Lamo soils contain more silt in the upper part of the profile and have a mollic epipedon that is more than 24 inches thick. Lawet soils are loamy throughout the profile. Lute soils are high in sodium content. Ord soils contain more sand in the upper part of the profile. Gannett soils are poorly drained or very poorly drained and are lower on the landscape.

Typical pedon of Lex loam, from an area of Lex-Lute loams, 0 to 2 percent slopes, 2,100 feet east and 100 feet north of the southwest corner of sec. 12, T. 30 N., R. 16 W.

Ap—0 to 5 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak fine granular structure; soft, friable; strong effervescence; mildly alkaline; clear smooth boundary.

A12—5 to 10 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate fine granular structure; soft, friable; strong effervescence; mildly alkaline; clear smooth boundary.

AC—10 to 25 inches; gray (10YR 6/1) silty clay loam, dark gray (10YR 4/1) moist; few fine distinct dark brown (10YR 3/3 moist) mottles; weak medium and fine subangular blocky structure; hard, firm; slight effervescence; mildly alkaline; clear smooth boundary.

C1—25 to 31 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; few fine distinct dark brown (10YR 3/3 moist) mottles; weak coarse subangular blocky structure; hard, firm; few small lime accumulations; mildly alkaline; clear wavy boundary.

IIC2—31 to 60 inches; light gray (10YR 7/2) coarse sand, light brownish gray (10YR 6/2) moist; single grained; loose; mildly alkaline.

The mollic epipedon ranges from 7 to 20 inches in thickness. Depth to coarse sand or gravelly coarse sand ranges from 20 to 40 inches. Calcium carbonates are typically at the surface.

The A horizon has hue of 10YR, value of 3 through 5 (2 or 3 moist), and chroma of 1. It is dominantly loam, but the range includes silt loam and silty clay loam. The A horizon is mildly alkaline or moderately alkaline. The AC horizon has hue of 10YR, value of 5 or 6 (2 through 4 moist), and chroma of 1 or 2. It is silty clay loam or silt loam. The AC horizon is mildly alkaline or moderately alkaline. Some pedons do not have an AC horizon. The C horizon has hue of 10YR or 2.5Y, value of 5 through 7 (4 through 6 moist), and chroma of 2 or 3. It is clay loam, loam, and sandy loam. This horizon is commonly stratified with silty clay loam and sandy clay loam. The C horizon is mildly alkaline or moderately alkaline. The IIC horizon has hue of 10YR, value of 7 or 8 (6 or 7 moist), and chroma of 2 or 3. It is coarse sand or gravelly coarse sand. The IIC horizon is mildly alkaline.

Libory series

The Libory series consists of deep, moderately well drained soils on stream terraces. Permeability is rapid in the upper part and moderate or moderately slow in the lower part. The upper part of the profile formed in reworked eolian sand and the lower part formed in loamy alluvium. Slope ranges from 0 to 3 percent.

Libory soils are adjacent to Dunday, Elsmere, Ipage, Lawet, and Whitelake soils. Dunday, Ipage, and Whitelake soils are in similar positions on the landscape. Dunday and Ipage soils have a sandy control section. The Dunday soils are somewhat excessively drained. Whitelake soils are high in sodium content. Elsmere and Lawet soils are lower on the landscape and are

somewhat poorly drained. Elsmere soils are sandy. Lawet soils are somewhat poorly drained.

Typical pedon of Libory loamy fine sand, 0 to 3 percent slopes, 1,900 feet east and 75 feet north of the southwest corner of sec. 3, T. 28 N., R. 13 W.

A11—0 to 12 inches; gray (10YR 5/1) loamy fine sand, very dark gray (10YR 3/1) moist; weak coarse subangular blocky structure parting to weak medium and fine granular; soft, very friable; neutral; clear smooth boundary.

A12—12 to 18 inches; grayish brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; weak medium and coarse subangular blocky structure parting to weak medium granular; soft, very friable; neutral; clear smooth boundary.

C1—18 to 30 inches; pale brown (10YR 6/3) fine sand, brown (10YR 5/3) moist; few fine faint yellowish brown (10YR 5/4 moist) mottles; single grained; loose; neutral; abrupt wavy boundary.

IIB2b—30 to 42 inches; light brownish gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; few fine distinct yellowish brown (10YR 4/6 moist) mottles; weak medium and fine subangular blocky structure; slightly hard, friable; mildly alkaline; gradual smooth boundary.

IIC2—42 to 60 inches; light gray (2.5Y 7/2) silty clay loam, light brownish gray (2.5Y 6/2) moist; common medium faint light yellowish brown (10YR 6/4 moist) mottles; massive; slightly hard, friable; mildly alkaline.

The mollic epipedon ranges from 10 to 20 inches in thickness. Depth to the loamy IIB2b horizon ranges from 20 to 36 inches. The soil ranges from medium acid to mildly alkaline.

The A horizon has value of 3 through 5 (2 through 4 moist) and chroma of 1 or 2. It is dominantly loamy fine sand, but the range includes loamy sand and fine sand. The C horizon has value of 5 through 8 (4 through 7 moist) and chroma of 2 or 3. It ranges from loamy fine sand to fine sand. The IIB2b horizon has value of 4 through 6 (3 through 5 moist) and chroma of 2 or 3. It is very fine sandy loam, silt loam, or silty clay loam. The IIC horizon has hue of 2.5Y, 5Y, or 10YR; value of 4 through 7 (3 through 6 moist); and chroma of 2 or 3. It ranges from silt loam to silty clay loam. Reddish brown or yellowish brown mottles are in the C, IIB2b, and IIC horizons. Calcium carbonates are in some pedons, generally in the IIC horizon.

Loretto series

The Loretto series consists of deep, well drained, moderately permeable soils that formed in loamy eolian material on uplands. Slope ranges from 2 to 6 percent.

Loretto soils are similar to Nora soils and are commonly adjacent to Anselmo, Jansen, O'Neill, and Paka soils. These soils are in similar landscape positions. Nora soils are siltier throughout. Anselmo soils contain more sand in the subsoil. Jansen and O'Neill soils have gravelly coarse sand at a depth of 20 to 40 inches. Paka soils are siltier throughout and formed in weathered siltstone.

Typical pedon of Loretto loam, 2 to 6 percent slopes, 2,500 feet east and 200 feet north of the southwest corner of sec. 23, T. 31 N., R. 9 W.

Ap—0 to 7 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, very friable; slightly acid; clear smooth boundary.

A12—7 to 11 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak coarse prismatic structure parting to weak medium and fine granular; slightly hard, very friable; medium acid; clear smooth boundary.

B1—11 to 18 inches; brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, very friable; slightly acid; clear wavy boundary.

B2t—18 to 40 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; weak coarse prismatic structure parting to weak medium and fine subangular blocky; hard, friable; few fine pebbles; neutral; gradual wavy boundary.

B3—40 to 52 inches; yellowish brown (10YR 5/4) silty clay loam, dark yellowish brown (10YR 4/4) moist; weak coarse prismatic structure parting to weak medium subangular blocky; hard, friable; few fine pebbles; mildly alkaline; gradual wavy boundary.

C—52 to 60 inches; light yellowish brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable; few fine gravel; few small carbonate concretions; mildly alkaline.

Thickness of the solum ranges from 35 to 55 inches. Depth to carbonates ranges from 35 to 54 inches. The mollic epipedon ranges from 7 to 20 inches in thickness.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 2. It is dominantly loam, but the range includes fine sandy loam. The A horizon is medium acid or slightly acid. The B2t horizon has value of 5 or 6 (4 or 5 moist) and chroma of 2 or 3. It is commonly silty clay loam and less commonly clay loam or loam. The B2t horizon is slightly acid or neutral. The C horizon has value of 6 or 7 (5 or 6 moist) and chroma of 3 or 4. It is commonly clay loam or silty clay loam and less commonly loam. The C horizon ranges from slightly acid to moderately alkaline.

Loup series

The Loup series consists of deep, poorly drained and very poorly drained, rapidly permeable soils that formed

in sandy alluvial material. These soils are in valleys in areas of the sandhills and on bottom lands along major drainageways. Slope ranges from 0 to 2 percent.

Loup soils are similar to Gannett and Tryon soils and adjacent to Elsmere, Inavale, Marlake, and Ord soils. Gannett and Tryon soils are in similar landscape positions. Gannett soils have a finer textured control section. Tryon soils do not have a mollic epipedon. Elsmere and Ord soils are higher on the landscape and are somewhat poorly drained. Inavale soils are higher on the landscape and are moderately well drained. The Marlake soils do not have a mollic epipedon, have a higher seasonal water table, and are lower on the landscape.

Typical pedon of Loup fine sandy loam, 0 to 2 percent slopes, 2,000 feet south and 400 feet east of the northwest corner of sec. 9, T. 27 N., R. 13 W.

A11—0 to 6 inches; very dark gray (10YR 3/1) fine sandy loam, black (10YR 2/1) moist; weak fine granular structure; soft, very friable; violent effervescence; mildly alkaline; abrupt smooth boundary.

A12—6 to 10 inches; dark gray (10YR 4/1) fine sandy loam, very dark gray (10YR 3/1) moist; weak coarse and medium subangular blocky structure; soft, very friable; moderately alkaline; clear smooth boundary.

AC—10 to 14 inches; gray (10YR 5/1) fine sand, dark gray (10YR 4/1) moist; few fine distinct dark brown (7.5YR 4/4) mottles; single grained; loose; neutral; clear smooth boundary.

C1—14 to 34 inches; light gray (10YR 7/2) fine sand, light brownish gray (10YR 6/2) moist; few fine faint yellowish brown (10YR 5/6) mottles; single grained; loose; few iron manganese concretions; neutral; gradual wavy boundary.

C2—34 to 48 inches; light gray (10YR 7/2) fine sand, light brownish gray (10YR 6/2) moist; many medium to coarse prominent reddish brown (5YR 4/4) and dark brown (10YR 3/3) mottles; single grained; loose; thin strata of fine sandy loam; neutral; gradual wavy boundary.

C3—48 to 57 inches; grayish brown (10YR 5/2) fine sand, dark gray (10YR 4/1) moist; few fine faint gray (10YR 6/1) mottles; single grained; loose; mildly alkaline; gradual wavy boundary.

A1b—57 to 60 inches; dark gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; many medium prominent dark brown (7.5YR 4/4) and strong brown (7.5YR 5/6) mottles; massive; soft, very friable; slightly acid.

Thickness of the solum ranges from 10 to 22 inches. The mollic epipedon ranges from 7 to 20 inches in thickness. The upper 5 to 15 inches is calcareous in some of the pedons. Other pedons are noncalcareous.

The A horizon has value of 3 or 4 (2 or 3 moist) and chroma of 1 or 2. It is fine sandy loam, but the range includes loam or loamy fine sand. The A horizon is neutral through moderately alkaline. The AC horizon has value of 5 or 6 (3 through 5 moist) and chroma of 1 or 2. It is loamy sand, fine sand, or sand. The AC horizon is neutral through moderately alkaline. The AC horizon commonly contains few to common, fine to medium, faint to distinct, reddish brown, strong brown, or yellowish brown mottles. The C horizon has value of 6 through 8 (4 through 7 moist) and chroma of 1 or 2. It is fine sand or sand. The C horizon ranges from neutral through moderately alkaline. It contains few to common, faint to distinct, reddish brown, strong brown, or yellowish brown mottles.

Lute series

The Lute series consists of deep, somewhat poorly drained soils that formed in sandy alluvium on bottom lands. Permeability is slow in the solum. Slope ranges from 0 to 2 percent. These soils are strongly alkaline or very strongly alkaline. Lute soils in Holt County are mapped only in complex with Lamo, Lawet, Lex, or Ord soils.

Lute soils are similar to Selia soils. They are commonly adjacent to Gannett, Lamo, Lawet, Lex, and Ord soils. Selia soils are in similar landscape positions and have more sand in the subsoil. Lamo, Lawet, Lex, and Ord soils are in similar positions on the landscape. These soils do not have the high sodium content. Lamo soils are siltier throughout. Lawet soils contain more clay in the lower part of the pedon. Lex soils have coarse sand at a depth of 20 to 40 inches. Ord soils contain less clay. Gannett soils are lower on the landscape and poorly drained or very poorly drained.

Typical pedon of Lute loam, from an area of Lex-Lute loams, 0 to 2 percent slopes, 1,900 feet west and 1,100 feet north of the southeast corner of sec. 17, T. 30 N., R. 15 W.

A2—0 to 4 inches; gray (10YR 6/1) loam, very dark gray (10YR 3/1) moist; weak fine granular structure; soft, friable; neutral; abrupt smooth boundary.

B21t—4 to 9 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate medium columnar prismatic structure parting to moderate medium subangular blocky; very hard, firm; slight effervescence; moderately alkaline; clear smooth boundary.

B22t—9 to 16 inches; gray (10YR 5/1) loam, very dark gray (10YR 3/1) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; very hard, firm; few fine thread-like accumulations of carbonates; strong effervescence; strongly alkaline; clear smooth boundary.

B3—16 to 23 inches; light gray (10YR 7/2) fine sandy loam, light brownish gray (10YR 6/2) moist; weak thick platy structure parting to weak medium and coarse subangular blocky; slightly hard, friable; slight effervescence; very strongly alkaline; clear smooth boundary.

C1—23 to 34 inches; light gray (10YR 7/2) loamy fine sand, grayish brown (10YR 5/2) moist; common fine distinct dark brown (7.5YR 4/4) mottles; single grained; loose; thin strata of fine sandy loam to loam; slight effervescence; very strongly alkaline; clear smooth boundary.

C2—34 to 60 inches; light brownish gray (10YR 6/2) sand, dark grayish brown (10YR 4/2) moist; single grained; loose; thin strata of loamy sand; strongly alkaline.

Solum thickness ranges from 12 to 30 inches. Depth to carbonates is 0 to 6 inches. The solum is moderately alkaline to very strongly alkaline except in the A2 horizon, which ranges from neutral to moderately alkaline.

The A2 horizon has value of 5 through 7 (3 through 5 moist) and chroma of 1 or 2. Typically, it is loam or fine sandy loam, but the range includes loamy fine sand. The B2t horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 to 3. It is loam, fine sandy loam, or sandy clay loam averaging 18 to 26 percent clay. The B3 and C horizons have value of 5 through 7 (4 through 6 moist) and chroma of 2 or 3. The C horizon is fine sandy loam to loamy sand stratified with finer and coarser texture.

In map unit Os (Ord-Lute fine sandy loams, 0 to 2 percent slopes), the Lute soil contains less clay in the subsoil than is defined for the range of the Lute series. This difference does not alter the usefulness and behavior of the soil.

Lynch series

The Lynch series consists of moderately deep, well drained, slowly permeable soils on uplands. These soils formed in clay residuum weathered from light colored shale. This shale is soft and very high in carbonates and gypsum. Slope ranges from 2 to 11 percent.

Lynch soils are adjacent to Bristow, Labu, Sansarc, and Verdel soils. Bristow soils are in similar landscape positions and are less than 20 inches thick over bedded shale. Labu and Sansarc soils are higher on the landscape and formed in dark shales. Verdel soils have a mollic epipedon and are on lower stream terraces.

Typical pedon of Lynch silty clay, 6 to 11 percent slopes, 1,100 feet east and 1,000 feet north of the southwest corner of sec. 33, T. 33 N., R. 11 W.

Ap—0 to 4 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak medium and fine granular structure; slightly hard, friable; strong effervescence; 10 percent calcium carbonates; moderately alkaline; clear smooth boundary.

A12—4 to 7 inches; grayish brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; weak medium and fine granular structure; slightly hard, friable; strong effervescence; 15 percent calcium carbonates; moderately alkaline; clear smooth boundary.

B2—7 to 21 inches; light yellowish brown (2.5Y 6/4) silty clay, olive brown (2.5Y 4/4) moist; weak coarse prismatic structure parting to moderate medium and fine subangular blocky; hard, firm; strong effervescence; 22 percent calcium carbonates; moderately alkaline; clear smooth boundary.

C—21 to 25 inches; light gray (2.5Y 7/2) silty clay, light olive brown (2.5Y 5/4) moist; weak thick platy structure parting to weak medium and fine subangular blocky; hard, firm; strong effervescence; 55 percent calcium carbonates; strongly alkaline; clear smooth boundary.

Cr—25 to 60 inches; white (2.5Y 8/2) bedded shale, light yellowish brown (2.5Y 6/4) moist; massive; hard, firm; lime and gypsum crystals interspersed with shale fragments; strong effervescence; 52 percent calcium carbonates; mildly alkaline.

Thickness of the solum is 20 to 30 inches. Depth to the bedded shale is 20 to 40 inches. Calcium carbonates range from 10 to 55 percent. Carbonates are typically at the surface. The soil is moderately alkaline or strongly alkaline above the bedded shale.

The A horizon has hue of 10YR or 2.5Y, value of 4 through 6 (3 or 4 moist), and chroma of 2 or 3. It is dominantly silty clay, but the range includes clay. The B horizon has hue of 10YR or 2.5Y, value of 5 or 6 (4 or 5 moist), and chroma of 2 through 4. It is silty clay or clay. The C and Cr horizons have hue of 2.5Y, value of 7 or 8 (5 or 6 moist), and chroma of 3 or 4.

Marlake series

The Marlake series consists of deep, very poorly drained, rapidly permeable soils that formed in alluvium or alluvium covered by eolian sand. These soils are in depressions or basins on valley floors and in low areas bordering lakes and streams. Because of the high water table, these soils are covered with water for most of the growing season. Slope ranges from 0 to 2 percent.

Marlake soils are adjacent to Els, Elsmere, Gannett, Loup, Ord, and Tryon soils. Els, Elsmere, and Ord soils are higher on the landscape and are somewhat poorly drained. Gannett, Loup, and Tryon soils are in slightly higher positions on the landscape. Gannett soils contain

more clay in the upper part of the profile. Loup soils have a mollic epipedon. Tryon soils are less stratified.

Typical pedon of Marlake fine sandy loam, 0 to 2 percent slopes, 800 feet east and 150 feet south of the northwest corner of sec. 24, T. 26 N., R. 13 W.

A1—0 to 7 inches; dark gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak fine subangular blocky structure parting to weak fine granular; soft, very friable; on the surface is a layer of partly decayed leaves and stems; slight effervescence; neutral; abrupt wavy boundary.

AC—7 to 16 inches; grayish brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; stratified and mixed with dark gray (10YR 4/1) fine sandy loam and light gray (10YR 7/2) sand; few fine distinct yellowish brown (10YR 5/6 moist) mottles; weak medium and coarse subangular blocky structure; soft, very friable; strong effervescence; moderately alkaline; clear wavy boundary.

C—16 to 60 inches; light gray (10YR 7/2) fine sand, light brownish gray (10YR 6/2) moist; few fine distinct yellowish brown (10YR 5/6 moist) mottles; single grained; loose; thin strata of loamy sand; mildly alkaline.

Thickness of the solum ranges from 6 to 25 inches. Mollic colors extend to a depth of 6 to 10 inches. Typically, carbonates are at the surface, but some pedons lack carbonates. Snail shells are common.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is dominantly fine sandy loam, but the range includes loamy fine sand. The A horizon is neutral or mildly alkaline. The AC horizon has value of 3 through 7 (2 through 6 moist) and chroma of 1 through 3. It is most commonly loamy sand or loamy fine sand and is stratified or mixed with coarse sand to silty clay loam. Strata range to as much as 3 inches in thickness. The C horizon ranges from neutral through moderately alkaline. The C horizon has value of 5 through 7 (4 through 6 moist) and chroma of 1 through 3. It is sand or fine sand. Strata of finer and coarser textured material and dark buried layers are common. The C horizon typically is neutral or mildly alkaline. A few pedons have layers of carbonate accumulations in the upper part of the C horizon. The AC and C horizons typically contain few to common, faint to prominent, yellowish brown or reddish brown mottles.

Meadin series

The Meadin series consists of excessively drained soils on uplands and stream terraces. Permeability is rapid in the upper part and very rapid in the lower part. These soils formed in sandy and loamy material deposited over gravelly coarse sand. Slope ranges from 0 to 30 percent.

Meadin soils are adjacent to Boelus, Jansen, O'Neill, Pivot, and Simeon soils. Boelus soils are lower on the landscape and have loamy underlying material. Jansen, O'Neill, and Pivot soils are in similar positions on the landscape and are thicker over gravelly coarse sand.

Typical pedon of Meadin sandy loam, 3 to 30 percent slopes, 1,000 feet north and 1,200 feet west of the southeast corner of sec. 9, T. 31 N., R. 12 W.

A1—0 to 8 inches; dark grayish brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, very friable; 5 percent by volume gravel; strongly acid; clear smooth boundary.

A2—8 to 12 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) moist; weak medium and coarse subangular blocky structure; slightly hard, very friable; 12 percent by volume gravel; medium acid; clear smooth boundary.

IIC1—12 to 16 inches; brown (10YR 5/3) gravelly coarse sand, dark brown (10YR 4/3) moist; single grained; loose; 30 percent by volume gravel; medium acid; gradual smooth boundary.

IIC2—16 to 60 inches; very pale brown (10YR 7/3) gravelly coarse sand, pale brown (10YR 6/3) moist; single grained; loose; 17 percent by volume gravel; medium acid.

Thickness of the solum ranges from 8 to 20 inches. Thickness of the mollic epipedon ranges from 7 to 17 inches. Depth to a mixture of sand and gravel ranges from 8 to 20 inches.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is dominantly sandy loam or loam, but the range includes loamy sand. The A horizon ranges from strongly acid through neutral. The AC horizon has value of 4 through 6 (3 or 4 moist) and chroma of 2 through 4. It is typically sandy loam, gravelly sandy loam, loamy sand, or gravelly loamy sand. The AC horizon ranges from medium acid through neutral. The IIC horizon has value of 5 through 7 (4 through 6 moist) and chroma of 2 through 4. The IIC horizon ranges from medium acid through neutral. The content of gravel in the IIC horizon ranges from 15 to 35 percent by volume. In some pedons, the IIC horizon is stratified with finer material.

Nimbro series

The Nimbro series consists of deep, well drained, moderately permeable soils on stream terraces. These soils formed in alluvium. Slope ranges from 0 to 2 percent.

The Nimbro soils in Holt County lack the fine stratification in the upper part of the profile that is typical for the Nimbro series. This difference does not alter the usefulness or behavior of the soils.

Nimbro soils are commonly adjacent to Anselmo, Cass, Lex, Lute, and Nora soils. Anselmo, Cass, and Nora soils are higher on the landscape. Anselmo and Cass soils contain less clay in the control section. Nora soils are siltier throughout. Lex and Lute soils are lower on the landscape and are somewhat poorly drained. Lute soils are high in sodium content.

Typical pedon of Nimbro silt loam, 0 to 2 percent slopes, 2,200 feet east and 100 feet north of the southwest corner of sec. 33, T. 25 N., R. 9 W.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silt loam, very dark gray (10YR 3/1) moist; weak fine granular structure; soft, very friable; strong effervescence; moderately alkaline; clear smooth boundary.

A12ca—7 to 15 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak fine granular; soft, very friable; violent effervescence; moderately alkaline; gradual smooth boundary.

C1ca—15 to 26 inches; gray (10YR 6/1) silt loam, dark gray (10YR 4/1) moist; common fine distinct yellowish brown (10YR 5/4 moist) mottles; weak medium and fine subangular blocky structure; soft, very friable; few thin strata of grayish brown (10YR 5/2); violent effervescence; moderately alkaline; clear smooth boundary.

C2—26 to 34 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; common fine distinct yellowish brown (10YR 5/4 moist) mottles; weak medium subangular blocky structure; soft, very friable; strong effervescence; moderately alkaline; clear smooth boundary.

C3—34 to 50 inches; light gray (2.5Y 7/2) loamy fine sand, grayish brown (2.5Y 5/2) moist; common fine faint yellowish brown (10YR 5/4 moist) mottles; weak medium subangular blocky structure; soft, very friable; slight effervescence; moderately alkaline; clear smooth boundary.

C4—50 to 60 inches; light gray (2.5Y 7/2) silt loam stratified with loamy fine sand, grayish brown (2.5Y 5/2) moist; common fine faint yellowish brown (10YR 5/4 moist) mottles; massive; slight effervescence; moderately alkaline.

The mollic epipedon and the solum range from 7 to 20 inches in thickness. Depth to free carbonates ranges from 0 to 20 inches. This soil is mildly alkaline or moderately alkaline throughout.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silt loam, but the range includes loam or fine sandy loam. The C horizon has hue of 2.5Y or 10YR, value of 5 through 7 (4 through 5 moist), and chroma of 1 through 3. It is clay loam, silt loam, or loam stratified with sandy loam to loamy fine sand. Coarse sand or gravelly coarse sand is below a depth of 40 inches in some pedons. Few or common mottles are in some layers.

Nora series

The Nora series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in calcareous loess (fig. 31). Slope ranges from 0 to 6 percent.

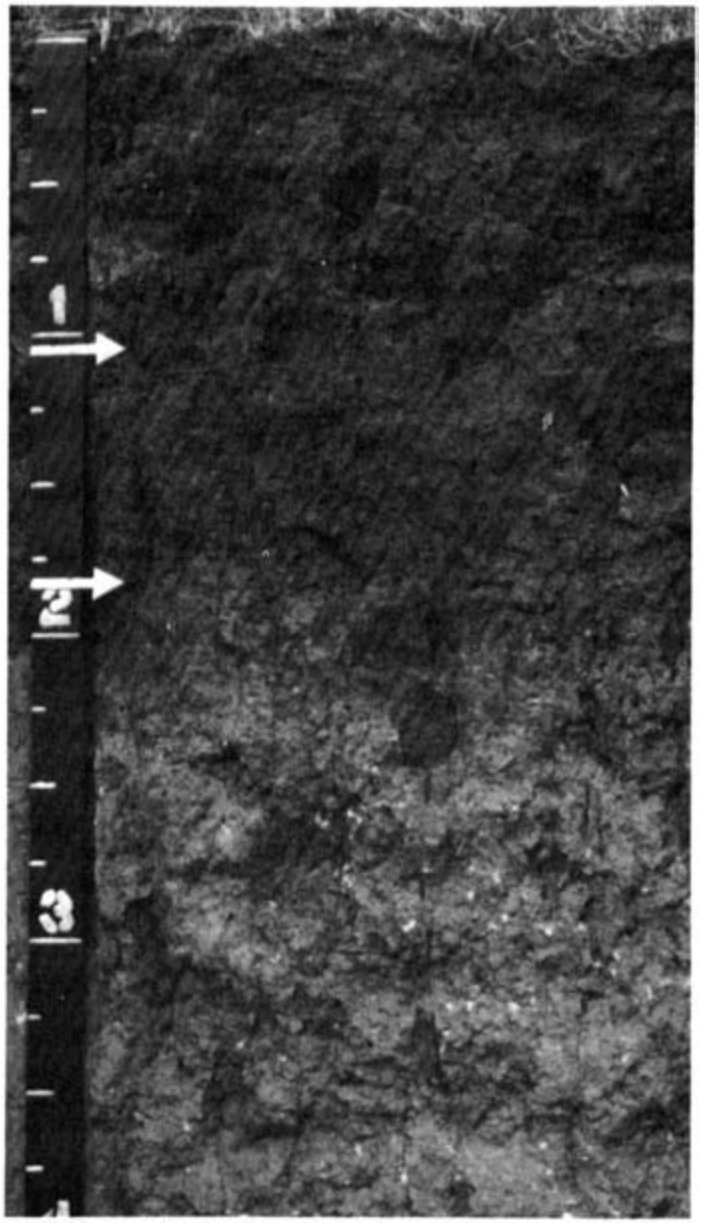


Figure 31.—Profile of Nora silt loam. The bottom arrow marks the depth to lime. The scale is in feet.

Nora soils are similar to Paka soils and are commonly adjacent to Anselmo, Bazile, Boelus, Loretto, and Trent soils. Paka soils are lower on the landscape and formed in weathered Tertiary material. Anselmo and Boelus soils are higher on the landscape. Anselmo soils contain more sand throughout. Boelus soils are sandy in the upper part and loamy in the lower part. Bazile and Loretto soils are in similar positions on the landscape. Bazile soils have a sandy substratum. Loretto soils contain more sand throughout. Trent soils have a mollic epipedon that is more than 20 inches thick. They are in upland swales.

Typical pedon of Nora silt loam, 0 to 2 percent slopes, 1,100 feet north and 100 feet west of the southeast corner of sec. 24, T. 31 N., R. 9 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable; neutral; abrupt smooth boundary.

B21—8 to 15 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure parting to weak fine subangular blocky; soft, very friable; slightly acid; clear smooth boundary.

B22—15 to 21 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; weak coarse prismatic structure parting to weak medium and fine subangular blocky; soft, very friable; neutral; clear smooth boundary.

B3—21 to 29 inches; light yellowish brown (2.5Y 6/4) silt loam, olive brown (2.5Y 4/4) moist; weak coarse prismatic structure parting to weak medium subangular blocky; soft, very friable; strong effervescence; moderately alkaline; clear wavy boundary.

C—29 to 60 inches; pale yellow (2.5Y 7/4) silt loam, light yellowish brown (2.5Y 6/4) moist; weak coarse prismatic structure; soft, very friable; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 20 to 36 inches. Depth to carbonates ranges from 18 to 30 inches. Thickness of the mollic epipedon ranges from 7 to 20 inches.

The A horizon has value of 4 (2 or 3 moist) and chroma of 2. It typically is silt loam about 7 to 12 inches thick. The A horizon is slightly acid or neutral. The B2 horizon has value of 5 or 6 (3 or 4 moist) and chroma of 3. It is silt loam or light silty clay loam. The B2 horizon ranges from slightly acid to mildly alkaline. The B3 horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 3 or 4. It is silt loam or light silty clay loam. The B3 horizon ranges from neutral to moderately alkaline. The C horizon has hue of 10YR or 2.5Y, value of 6 or 7 (5 or 6 moist), and chroma of 2 through 4. It is silt loam or light silty clay loam. The C horizon is mildly alkaline or moderately alkaline.

O'Neill series

The O'Neill series consists of well drained soils that formed in loamy and sandy outwash or eolian material (fig. 32). Permeability is moderately rapid over very rapid. These soils are moderately deep over sand, coarse sand, and gravelly coarse sand. O'Neill soils are on

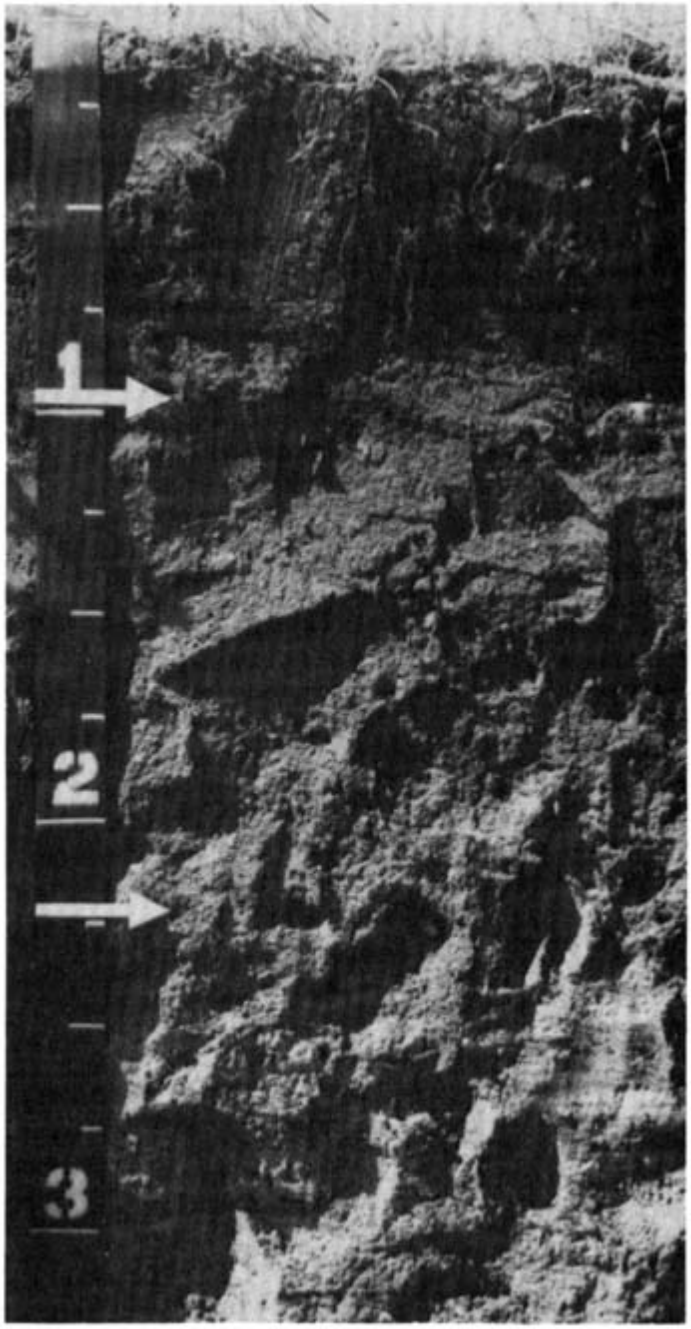


Figure 32.—Profile of O'Neill fine sandy loam. The arrows indicate the lower boundaries of the surface layer and subsoil, respectively. The scale is in feet.

uplands and stream terraces. Slope ranges from 0 to 30 percent.

O'Neill soils are commonly adjacent to Anselmo, Brunswick, Dunday, Dunn, Jansen, Meadin, and Pivot soils. These soils are all on similar landscape positions. Anselmo soils do not have coarse sand or gravelly coarse sand in the control section. Brunswick soils have sandstone at a depth of 20 to 40 inches. Dunday and Pivot soils have more sand in the control section. Dunn soils have loamy underlying material. Jansen soils have more clay in the subsoil. Meadin soils have gravelly coarse sand at a depth of 8 to 20 inches.

Typical pedon of O'Neill fine sandy loam, 0 to 2 percent slopes, 2,200 feet east and 500 feet north of the southwest corner of sec. 14, T. 29 N., R. 11 W.

Ap—0 to 8 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; strongly acid; abrupt smooth boundary.

A12—8 to 12 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) moist; weak medium and fine granular structure; soft, very friable; strongly acid; clear wavy boundary.

B2—12 to 26 inches; brown (10YR 5/3) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure parting to weak medium and fine subangular blocky; soft, very friable; neutral; gradual wavy boundary.

IIC1—26 to 30 inches; pale brown (10YR 6/3) sand, brown (10YR 5/3) moist; single grained; loose; 5 percent gravel by volume; slightly acid; gradual wavy boundary.

IIC2—30 to 60 inches; very pale brown (10YR 7/3) coarse sand, pale brown (10YR 6/3) moist; single grained; loose; 13 percent gravel by volume; slightly acid.

The mollic epipedon ranges from 7 to 20 inches in thickness and extends into the B horizon in some pedons. The solum ranges from 20 to 32 inches in thickness. The soil ranges from strongly acid to neutral.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is loam, fine sandy loam, or loamy sand. The B horizon has value of 4 or 5 (3 or 4 moist) and chroma of 2 through 4. It is fine sandy loam or sandy loam. In places, clay has accumulated in the lower part of the B2 horizon so that this layer is noticeably finer in texture than the layer above or below. The IIC horizon has value of 6 or 7 (5 or 6 moist) and chroma of 3 or 4. It is sand, coarse sand, or gravelly coarse sand.

Ord series

The Ord series consists of deep, somewhat poorly drained soils on bottom lands. Permeability is moderately rapid in the upper part and rapid in the lower part. These soils formed in stratified alluvium. Slope ranges from 0 to 2 percent.

Ord soils are adjacent to Cass, Elsmere, Gannett, Lex, Loup, and Lute soils. Cass soils are higher on the landscape and are better drained. Elsmere soils are in similar positions and are sandier throughout. Gannett and Loup soils are lower on the landscape and are poorly drained and very poorly drained. Lex and Lute soils are in similar positions on the landscape. Lex soils have more clay in the upper part of the control section and coarse sand in the lower part of the control section. Lute soils are strongly affected with alkali.

Typical pedon of Ord loam, 0 to 2 percent slopes, 2,200 feet east and 100 feet north of the southwest corner of sec. 30, T. 25 N., R. 11 W.

A11ca—0 to 12 inches; gray (10YR 5/1) loam, very dark gray (10YR 3/1) moist; weak fine granular structure; slightly hard, very friable; strong effervescence; moderately alkaline; abrupt smooth boundary.

A12—12 to 17 inches; dark gray (10YR 4/1) fine sandy loam, very dark gray (10YR 3/1) moist; weak medium and fine granular structure; slightly hard, very friable; slight effervescence; mildly alkaline; abrupt wavy boundary.

AC—17 to 24 inches; light brownish gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak coarse subangular blocky structure; soft, very friable; mildly alkaline; abrupt wavy boundary.

IIC—24 to 60 inches; light gray (10YR 7/2) sand, grayish brown (10YR 5/2) moist; few medium faint yellowish brown (10YR 5/4 moist) mottles; single grained; loose; thin strata of loamy fine sand; mildly alkaline.

Thickness of the solum ranges from 20 to 34 inches; it commonly is the same as the depth to the underlying fine sand. The mollic epipedon ranges from 10 to 20 inches in thickness. Carbonates are at or near the surface.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1. It is loam or fine sandy loam 10 to 20 inches thick. The AC horizon has value of 5 or 6 (4 or 5 moist) and chroma of 1 or 2. It is fine sandy loam, but some pedons have thin strata of loamy fine sand. Mottles are in the AC horizon in some pedons. The IIC horizon has value of 6 or 7 (5 or 6 moist) and chroma of 2. It has mottles. The C horizon is dominantly fine sand, but some pedons contain strata of finer and coarse sediment.

Paka series

The Paka series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in silty and loamy material weathered from siltstone. Slope ranges from 0 to 11 percent.

Paka soils are similar to Nora soils and are commonly adjacent to Anselmo, Boelus, Brunswick, Jansen, Labu, Loretto, and O'Neill soils. Nora, Anselmo, Boelus, Jansen, Loretto, and O'Neill soils are normally higher on the landscape. Nora soils formed in loess and do not have underlying siltstone. Anselmo and O'Neill soils contain more sand throughout. O'Neill soils also have gravelly coarse sand or coarse sand at a depth of 20 to 40 inches. Boelus soils have a sandy over loamy control section. Jansen soils have gravelly coarse sand at a depth of 20 to 40 inches. Loretto soils have more sand in the subsoil and underlying material. Labu soils are lower on the landscape, formed in dark shale, and contain more clay.

Typical pedon of Paka loam, 2 to 6 percent slopes, 800 feet east and 300 feet south of the northwest corner of sec. 12, T. 28 N., R. 10 W.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable; neutral; abrupt smooth boundary.

B21t—9 to 15 inches; grayish brown (10YR 5/2) light silty clay loam, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure parting to weak fine subangular blocky; slightly hard, friable; mildly alkaline; clear smooth boundary.

B22t—15 to 20 inches; brown (10YR 5/3) silt loam, dark brown (10YR 4/3) moist; weak coarse prismatic structure parting to weak medium and fine subangular blocky; soft, very friable; mildly alkaline; clear smooth boundary.

B3—20 to 26 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; weak medium and coarse subangular blocky structure; soft, very friable; mildly alkaline; gradual wavy boundary.

Cca—26 to 44 inches; very pale brown (10YR 8/3) silt loam, pale brown (10YR 6/3) moist; massive; soft, very friable; few soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

Cr—44 to 60 inches; white (10YR 8/2) weakly cemented siltstone, very pale brown (10YR 7/3) moist; violent effervescence.

Solum thickness ranges from 20 to 38 inches. Depth to bedrock ranges from 40 to 60 inches. Depth to carbonates ranges from 16 to 30 inches.

The A horizon has value of 3 or 4 (2 or 3 moist) and chroma of 2 or 3. It is dominantly loam or fine sandy loam, but the range includes silt loam or silty clay loam. The B2t horizon has hue of 7.5YR, 10YR, or 2.5Y; value of 5 through 7 (4 through 6 moist); and chroma of 2 or 3. It is silty clay loam, clay loam, or silt loam and averages 24 to 32 percent clay. The B2t horizon is mildly alkaline or moderately alkaline. The C and Cr horizons have hue of 7.5YR, 10YR, or 2.5Y; value of 7 or 8 (5 through 7 moist); and chroma of 2 through 4. The C horizon is silt loam or very fine sandy loam. The C and Cr horizons are mildly alkaline or moderately alkaline.

Map unit PhD2 (Paka loam, 6 to 11 percent slopes, eroded) does not have a mollic epipedon. This difference does not alter the usefulness or behavior of the soil.

Pivot series

The Pivot series consists of somewhat excessively drained soils that formed in sandy outwash or eolian sand over coarse sand or gravelly coarse sand (fig. 33). These soils are moderately deep over gravelly coarse sand. They are on uplands and stream terraces. Permeability is rapid in the upper part and very rapid in the lower part. Slope ranges from 0 to 20 percent.

Pivot soils are adjacent to Boelus, Brunswick, Dunday, Dunn, Meadin, and O'Neill soils. Boelus, Brunswick, and O'Neill soils are in similar positions on the landscape. Boelus soils have loamy underlying material. Brunswick soils have sandstone at a depth of 20 to 40 inches. O'Neill soils have more clay in the subsoil. Dunday and Dunn soils are slightly higher on the landscape. Dunday soils do not have gravel in the underlying material. Dunn soils have loamy material at a depth of 20 to 40 inches. Meadin soils are lower on the landscape and have gravelly coarse sand at a depth of 8 to 20 inches.

Typical pedon of Pivot loamy sand, 0 to 3 percent slopes, 2,200 feet east and 230 feet south of the northwest corner of sec. 35, T. 29 N., R. 11 W.

A11—0 to 6 inches; dark gray (10YR 4/1) loamy sand, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak medium and fine granular; soft, very friable; common fine roots; medium acid; clear smooth boundary.

A12—6 to 16 inches; dark grayish brown (10YR 4/2) loamy sand, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure parting to weak medium granular; soft, very friable; very fine roots; medium acid; clear smooth boundary.

AC—16 to 21 inches; grayish brown (10YR 5/2) loamy sand, dark grayish brown (10YR 4/2) moist; weak coarse and medium subangular blocky structure; soft, very friable; few very fine roots; few fine pebbles; medium acid; clear smooth boundary.

C1—21 to 28 inches; brown (10YR 5/3) coarse sand, dark brown (10YR 4/3) moist; single grained; loose, very friable; few very fine roots; 11 percent by volume fine gravel; medium acid; clear smooth boundary.

IIC2—28 to 60 inches; pale brown (10YR 6/3) gravelly coarse sand, brown (10YR 5/3) moist; single grained; loose; 35 percent by volume fine and medium gravel; medium acid.

The mollic epipedon ranges from 10 to 20 inches in thickness and may extend into the AC horizon. The soil

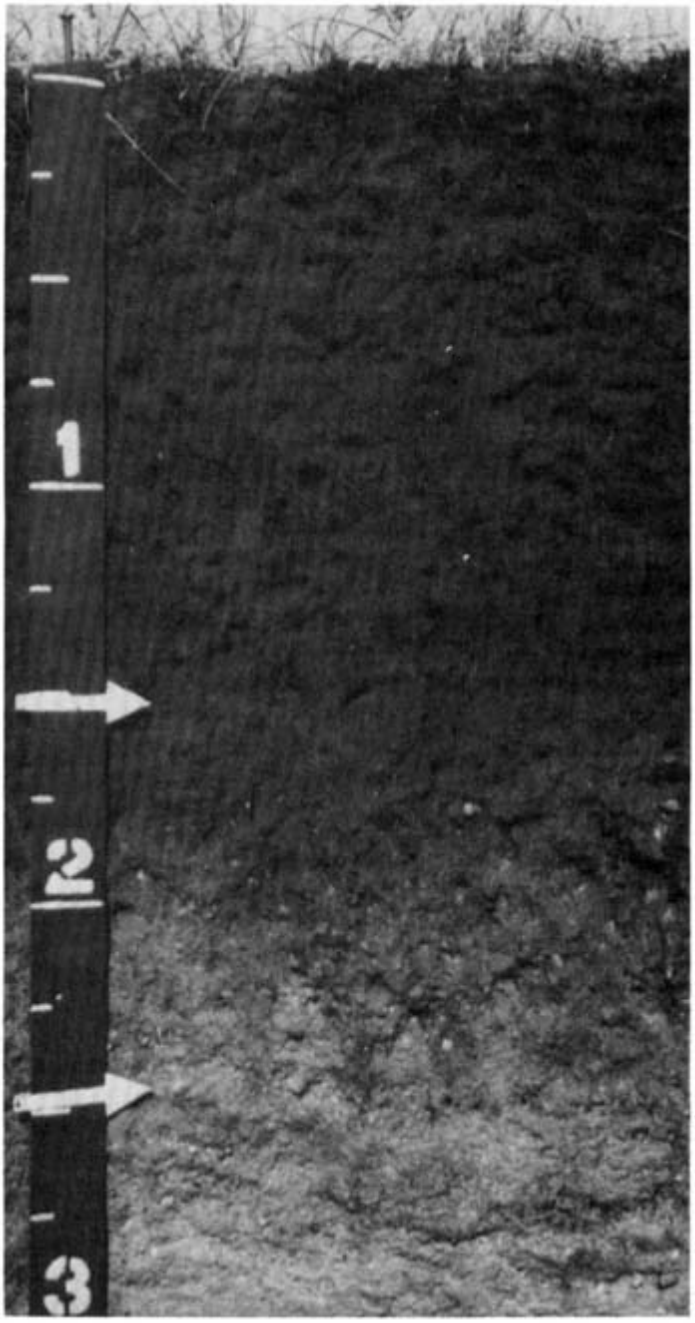


Figure 33.—A profile of Pivot loamy sand. The top arrow marks the lower boundary of the dark surface layer. The bottom arrow marks the upper boundary of the gravelly coarse sand. The scale is in feet.

ranges from medium acid to neutral. Depth to the IIC horizon is 20 to 40 inches.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is loamy sand, but the range includes loamy fine sand. The AC horizon has value of 4 or 5 (3 or 4 moist) and chroma of 2 or 3. It is sand, loamy coarse sand, or loamy sand. The C horizon has value of 5 or 6 (4 or 5 moist) and chroma of 3 or 4. It is loamy coarse sand or coarse sand. In a few pedons, loamy material has accumulated in the lower part of the C horizon so that the layer is noticeably finer in texture than the layers above and below. The IIC2 horizon has value of 5 through 7 (4 through 6 moist) and chroma of 2 or 3. Gravel content ranges from 5 to 35 percent by volume.

Sansarc series

The Sansarc series consists of shallow, well drained, slowly permeable soils on uplands. These soils formed in clayey residuum weathered from dark shale (fig. 34). Slope ranges from 11 to 40 percent.

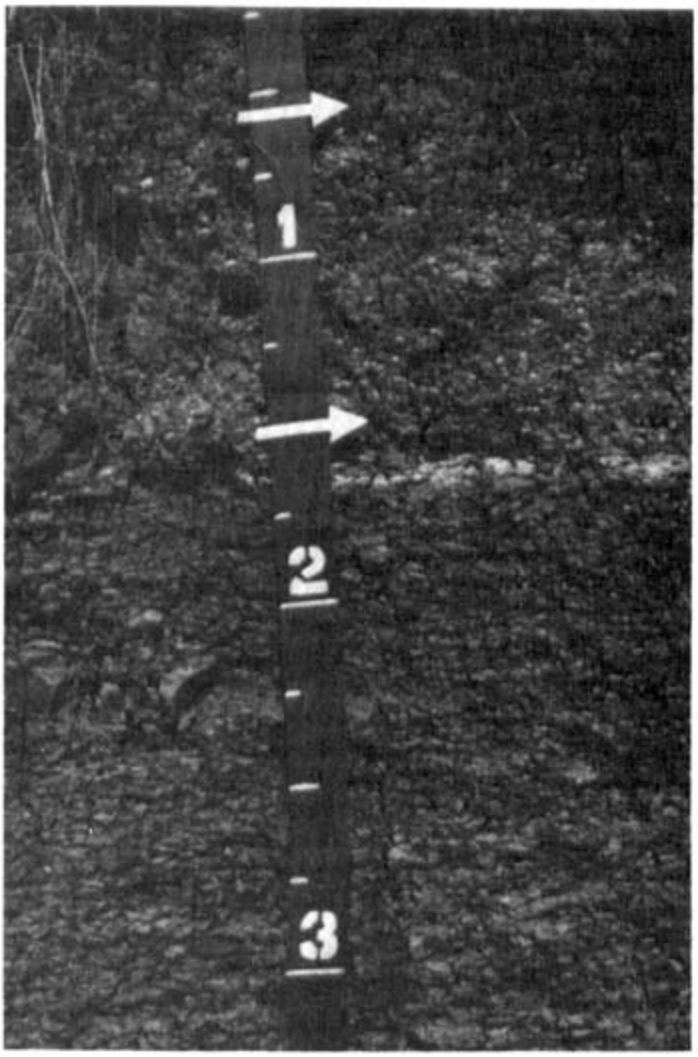


Figure 34.—Profile of Sansarc silty clay. This shallow, clayey soil formed in clayey residuum weathered from shale. The bottom arrow marks the upper boundary of the bedded shale. The scale is in feet.

Sansarc soils are adjacent to Bristow, Labu, Simeon, and Verdel soils. Bristow soils are lower on the landscape and formed in light colored shale high in content of gypsum and carbonates. Labu soils are in similar landscape positions and are more than 20 inches thick over shale. Simeon soils are sandy throughout the profile and are higher on the landscape. Verdel soils are deep, have a thick mollic epipedon, and are on foot slopes and stream terraces.

Typical pedon of Sansarc silty clay, from an area of Labu-Sansarc silty clays, 11 to 30 percent slopes, 2,100 feet north and 600 feet east of the southwest corner of sec. 19, T. 32 N., R. 11 W.

A1—0 to 4 inches; dark grayish brown (2.5Y 4/2) silty clay, very dark grayish brown (2.5Y 3/2) moist; moderate fine granular structure; very hard, firm; slight effervescence; mildly alkaline; abrupt smooth boundary.

C1—4 to 12 inches; pale brown (10YR 6/3) shaly clay, brown (10YR 4/3) moist; weak medium subangular blocky structure parting to moderate fine granular; hard, firm; 18 percent shale fragments; gypsum and lime accumulations in cleavages; slight effervescence; mildly alkaline; clear smooth boundary.

Cr—12 to 60 inches; pale brown (10YR 6/3) and light yellowish brown (10YR 6/4) bedded shale, brown (10YR 5/3) and dark yellowish brown (10YR 4/4) moist; lime and gypsum in cleavages and seams in the shale; slight effervescence; mildly alkaline.

Depth to bedded shale ranges from 4 to 20 inches. The soil ranges from neutral to moderately alkaline.

The A horizon has hue of 10YR or 2.5Y, value of 4 through 6 (3 through 5 moist), and chroma of 2 or 3. It is silty clay or clay 2 to 4 inches thick. The C horizon has hue of 10YR through 5Y, value of 5 through 7 (4 through 6 moist), and chroma of 2 through 4. The C horizon contains as much as 50 percent or more shale fragments by volume. The Cr horizon is bedded shale that has a wide range of color.

Selia series

The Selia series consists of deep, somewhat poorly drained soils that formed in sandy alluvium on bottom lands. Permeability is slow in the solum and rapid in the underlying material. These soils are high in exchangeable sodium. Slope ranges from 0 to 2 percent. Selia soils in Holt County are mapped only in complex with Elsmere soils.

Selia soils are similar to Lute soils and are commonly adjacent to Els, Elsmere, Ipage, Loup, Tryon, and Valentine soils. Lute, Els, and Elsmere soils are in similar landscape positions. Lute soils have a finer textured solum. Els and Elsmere soils do not have the high sodium content. Elsmere soils have a mollic epipedon. Ipage and Valentine soils are higher on the landscape and are better drained. Loup and Tryon soils are in lower landscape positions and are poorly drained and very poorly drained.

Typical pedon of Selia loamy fine sand, from an area of Elsmere-Selia loamy fine sands, 0 to 2 percent slopes, 1,250 feet west and 150 feet south of the northeast corner of sec. 21, T. 27 N., R. 13 W.

A1—0 to 3 inches; gray (10YR 5/1) loamy fine sand, black (10YR 2/1) moist; weak granular structure; soft, very friable; neutral; abrupt wavy boundary.

A2—3 to 4 inches; light gray (10YR 6/1) fine sand, dark gray (10YR 4/1) moist; single grained; loose; neutral: abrupt wavy boundary.

B21t—4 to 12 inches; dark gray (10YR 4/1) loamy fine sand, very dark gray (10YR 3/1) moist; weak coarse columnar structure parting to weak coarse subangular blocky; very hard, friable; few clay bridgings between sand grains; many fine and medium thread-like accumulations of carbonates; strong effervescence; strongly alkaline; clear wavy boundary.

B22t—12 to 16 inches; grayish brown (10YR 5/2) loamy fine sand, dark gray (10YR 4/1) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; very hard, friable; few clay bridgings between sand grains; few fine thread-like accumulations of carbonates; slight effervescence; very strongly alkaline; clear wavy boundary.

B3—16 to 25 inches; light brownish gray (10YR 6/2) loamy fine sand, grayish brown (10YR 4/2) moist; few fine faint yellowish brown (10YR 5/6 moist) mottles; weak coarse prismatic structure; very hard, friable; few fine thread-like accumulations of carbonates; slight effervescence; very strongly alkaline; abrupt smooth boundary.

C1—25 to 40 inches; light gray (10YR 7/2) fine sand, grayish brown (10YR 7/2) moist; common medium and fine distinct reddish brown (5YR 5/4 moist) mottles; single grained; loose; neutral; clear smooth boundary.

C2—40 to 60 inches; grayish brown (10YR 5/2) sand; dark grayish brown (10YR 4/2) moist; common medium and fine distinct reddish brown (5YR 5/4 moist) mottles; single grained; loose; neutral.

Thickness of the solum ranges from 15 to 32 inches. Carbonates are typically below the A horizon, but they are at the surface in some pedons.

The A1 horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is fine sand, loamy sand, or loamy fine sand. The A horizon ranges from neutral through strongly alkaline. Some pedons do not have an A1 horizon. The A2 horizon has value of 5 through 8 (4 through 7 moist). It is fine sand, loamy sand, or loamy fine sand. The A2 horizon is neutral to very strongly

alkaline. The B2t horizon has hue of 10YR or 2.5Y, value of 4 or 5 (3 or 4 moist), and chroma of 1 through 3. It is loamy sand or loamy fine sand. It is more than 15 percent exchangeable sodium. The B2t horizon is strongly alkaline or very strongly alkaline. The C horizon has hue of 10YR or 2.5Y, value of 5 through 7 (4 through 6 moist), and chroma of 2 or 3. It is sand, fine sand, loamy sand, and loamy fine sand. In some pedons, the lower part of the C horizon is thinly stratified with finer and coarser material. It has few to many, faint to distinct, yellowish brown, reddish brown, or brown mottles. The C horizon is neutral to very strongly alkaline. Loamy material is below a depth of 40 inches in some pedons.

Simeon series

The Simeon series consists of deep, excessively drained, rapidly permeable soils on uplands and stream terraces. These soils formed in sandy alluvium and outwash material. Slope ranges from 0 to 30 percent.

Simeon soils are adjacent to Labu, Meadin, Pivot, Sansarc, Valentine, and Wewela soils. Labu and Sansarc soils are lower on the landscape and are clayey. Meadin, Pivot, and Wewela soils are in similar positions. Meadin soils have gravelly coarse sand at a depth of 8 to 20 inches. Pivot soils have gravelly coarse sand at a depth of 20 to 40 inches. Wewela soils have more clay throughout. Valentine soils contain less medium and coarse sand in the C horizon than Simeon soils.

Typical pedon of Simeon loamy sand, 0 to 3 percent slopes, 2,000 feet west and 2,000 feet south of the northeast corner of sec. 25, T. 33 N., R. 13 W.

A1—0 to 8 inches; grayish brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; neutral; gradual smooth boundary.

AC—8 to 18 inches; brown (10YR 5/3) sand, dark brown (10YR 4/3) moist; single grained; loose; 1 percent by volume gravel; slightly acid; gradual wavy boundary.

C1—18 to 36 inches; light yellowish brown (10YR 6/4) coarse sand, yellowish brown (10YR 5/4) moist; single grained; loose; 5 percent by volume gravel; slightly acid; clear smooth boundary.

C2—36 to 60 inches; very pale brown (10YR 7/3) sand, pale brown (10YR 6/3) moist; single grained; loose; slightly acid.

Thickness of the solum ranges from 7 to 20 inches. Simeon soils are slightly acid or neutral throughout the profile.

The A horizon has value of 4 or 5 (3 or 4 moist) and chroma of 1 or 2. It is loamy sand or sand, but the range includes fine sand. The C horizon has value of 6 through 8 (5 through 7 moist) and chroma of 2 through 4. The C horizon typically is coarse sand, loamy coarse sand, or sand, but the range includes loamy sand that has more than 35 percent medium and coarse sand. Gravel content in the C horizon ranges to as much as 15 percent by volume.

Tassel series

The Tassel series consists of shallow, well drained soils. Permeability is rapid. These soils formed in calcareous, soft sandstone. Slope ranges from 11 to 40 percent.

The Tassel soils in Holt County are in a more humid climate than is typical for the Tassel series. This difference, however, does not affect the use or behavior of these soils.

Tassel soils are adjacent to Brunswick, Meadin, O'Neill, and Paka soils. Brunswick soils are in similar positions and have noncalcareous, soft sandstone at a depth of 20 to 40 inches. Meadin and O'Neill soils are usually in higher positions on the landscape. Meadin soils have gravelly coarse sand at a depth of 8 to 20 inches. O'Neill soils have gravelly coarse sand at a depth of 20 to 40 inches. The deep Paka soils are on gentler slopes and contain more clay throughout.

Typical pedon of Tassel fine sandy loam, from an area of Brunswick-Tassel fine sandy loams, 11 to 40 percent slopes, 1,800 feet south and 800 feet west of the northeast corner of sec. 36, T. 31 N., R. 13 W.

A1—0 to 5 inches; light brownish gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; soft, very friable; strong effervescence; mildly alkaline; clear smooth boundary.

C—5 to 14 inches; light gray (10YR 7/2) fine sandy loam, grayish brown (10YR 5/2) moist; weak medium and coarse subangular blocky structure; soft, very friable; violent effervescence; mildly alkaline; few soft sandstone fragments; gradual wavy boundary.

Cr—14 to 60 inches; light gray (2.5Y 7/2) soft bedded sandstone, light brownish gray (2.5Y 6/2) moist; violent effervescence.

Depth to the sandstone bedrock ranges from 10 to 20 inches. Tassel soils are mildly alkaline or moderately alkaline and contain carbonates throughout. In some pedons, the carbonates are leached from the A horizon.

The A horizon has value of 4 through 7 (3 through 5 moist) and chroma of 2 or 3. It is fine sandy loam or loamy fine sand 3 to 9 inches thick. The C horizon has hue of 10YR, 2.5Y, or 5Y; value of 6 through 8 (5 through 7 moist); and chroma of 2 or 3. The control section typically is fine sandy loam. The Cr horizon is soft sandstone and is easily dug with a spade. Colors are similar to those of the C horizon. The Cr horizon crushes to fine sand.

Trent series

The Trent series consists of deep, moderately well drained, moderately permeable soils on uplands. These soils formed in loess or silty sediment. Slope ranges from 0 to 2 percent.

Trent soils are similar to Nora soils and adjacent to Bazile, Fillmore, and Jansen soils. Nora, Bazile, and Jansen soils are higher on the landscape. Nora soils have a mollic epipedon that is less than 20 inches thick. Bazile soils have sand at a depth of 20 to 40 inches. Jansen soils have gravelly coarse sand at a depth of 20 to 40 inches. Fillmore soils are in depressions. They are poorly drained and contain more clay in the subsoil.

Typical pedon of Trent silt loam, 0 to 3 percent slopes, 900 feet north and 100 feet west of the southeast corner of sec. 27, T. 29 N., R. 9 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium and fine granular structure; soft, very friable; medium acid; abrupt smooth boundary.

A12—6 to 11 inches; dark grayish brown (10YR 4/2) silt loam, very dark gray (10YR 3/1) moist; weak medium granular structure parting to weak fine granular; soft, very friable; medium acid; clear smooth boundary.

B21—11 to 24 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate coarse subangular blocky structure parting to weak medium and fine subangular blocky; slightly hard, friable; slightly acid; clear smooth boundary.

B22—24 to 32 inches; brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) moist; moderate coarse subangular blocky structure parting to weak medium and fine subangular blocky; slightly hard, friable; slightly acid; clear smooth boundary.

B3—32 to 40 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; moderate coarse subangular blocky structure parting to moderate medium and fine subangular blocky; slightly hard, friable; slightly acid; clear wavy boundary.

C—40 to 60 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; few fine faint brownish yellow (10YR 6/6 moist) mottles; massive; slightly hard, friable; neutral; clear wavy boundary.

Thickness of the solum ranges from 35 to 54 inches. Thickness of the mollic epipedon ranges from 20 to 40 inches.

The A horizon has value of 3 or 4 (2 or 3 moist) and chroma of 1 or 2. It is dominantly silt loam, but the range includes silty clay loam. The A horizon ranges from medium acid to neutral. The B horizon has value of 3 through 6 (2 through 5 moist) and chroma of 2 through 4. It is slightly acid or neutral. The B horizon is silt loam or silty clay loam. The C horizon has value of 5 through 7 (4 through 6 moist) and chroma of 2 or 3. It is silt loam or silty clay loam. The C horizon has few or common, faint and distinct mottles.

Tryon series

The Tryon series consists of deep, poorly drained and very poorly drained, rapidly permeable soils that formed in wind- and water-deposited sands (fig. 35). These soils are on valley floors, around lakes, and on bottom lands along streams in the sandhills. Slope ranges from 0 to 2 percent.

Tryon soils are similar to Loup and commonly adjacent to Els, Inavale, Ipage, Marlake, and Valentine soils. Els soils are higher on the landscape and are somewhat poorly drained. Loup soils have a mollic epipedon and are in similar landscape positions. Inavale and Ipage soils are higher on the landscape and are better drained. Marlake soils are lower on the landscape and are wet for longer periods. Valentine soils are on the steeper dune topography and are excessively drained.

Typical pedon for the Tryon loamy fine sand, 0 to 2 percent slopes, 1,600 feet north and 1,500 feet west of the southeast corner of sec. 17, T. 28 N., R. 13 W.

A11—0 to 4 inches; dark gray (10YR 4/1) loamy fine sand, very dark gray (10YR 3/1) moist; few fine faint strong brown (7.5YR 5/8 moist) mottles; weak fine granular structure; soft, very friable; moderately alkaline; clear smooth boundary.

A12—4 to 8 inches; dark gray (10YR 4/1) loamy fine sand, very dark gray (10YR 3/1) moist; common fine distinct dark reddish brown (5YR 3/4 moist) mottles; single grained; soft, very friable; mildly alkaline; clear smooth boundary.

C1—8 to 14 inches; pale brown (10YR 6/3) fine sand, brown (10YR 5/3) moist; many medium distinct strong brown (7.5YR 5/6 moist) mottles; single grained; loose; mildly alkaline; clear smooth boundary.

A13b—14 to 18 inches; gray (10YR 5/1) loamy sand, very dark gray (10YR 3/1) moist; common fine faint yellowish brown (10YR 5/6 moist) mottles; single grained; loose; mildly alkaline; clear wavy boundary.

C2—18 to 29 inches; light gray (10YR 7/2) fine sand, brown (10YR 5/3) moist; common fine distinct strong brown (7.5YR 5/6 moist) mottles; single grained; loose; slightly acid; clear wavy boundary.

C3—29 to 43 inches; gray (10YR 5/1) fine sand, dark grayish brown (10YR 4/2) moist; few coarse distinct dark brown (10YR 4/3 moist) mottles; single grained; loose; many fine strata of light and dark material; slightly acid; clear wavy boundary.

C4—43 to 60 inches; light brownish gray (10YR 6/2) fine sand, grayish brown (10YR 5/2) moist; few fine faint dark yellowish brown (10YR 4/4 moist) mottles; single grained; loose; neutral.

Thickness of the solum ranges from 3 to 9 inches. The

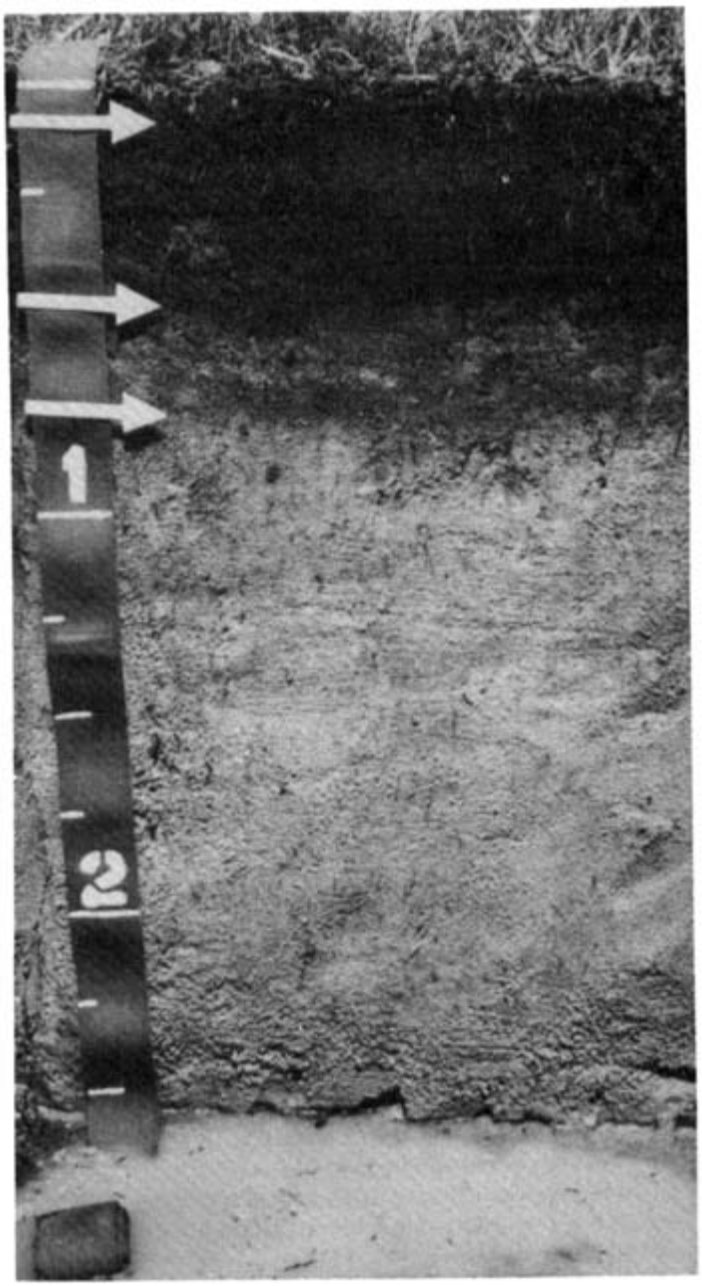


Figure 35.—Profile of Tryon loamy fine sand. This sandy soil has a thin surface layer. The water table is at a depth of about 30 inches. The scale is in feet.

pedons contain few to many, fine to coarse, faint to prominent, reddish brown, strong brown, or yellowish brown mottles. Some pedons contain carbonates near the surface.

The A horizon has value of 3 through 5 (2 or 3 moist) and chroma of 1 or 2. It is loamy fine sand, fine sand, and loamy sand 3 to 9 inches thick. The A horizon is medium acid through moderately alkaline. Some pedons have an AC horizon that ranges from 1 to 5 inches in thickness. It is fine sand or loamy sand. The C horizon has value of 5 through 8 (4 through 7 moist) and chroma of 1 through 3. It is fine sand. The C horizon is slightly acid through mildly alkaline. Some pedons have buried layers of loamy fine sand 1 to 8 inches thick between depths of 10 to 40 inches. Thicker layers of finer textured material are common below a depth of 40 inches.

Valentine series

The Valentine series consists of deep, excessively drained, rapidly permeable soils that formed in sandy, windblown material on uplands (fig. 36). Slope ranges from 0 to 60 percent.

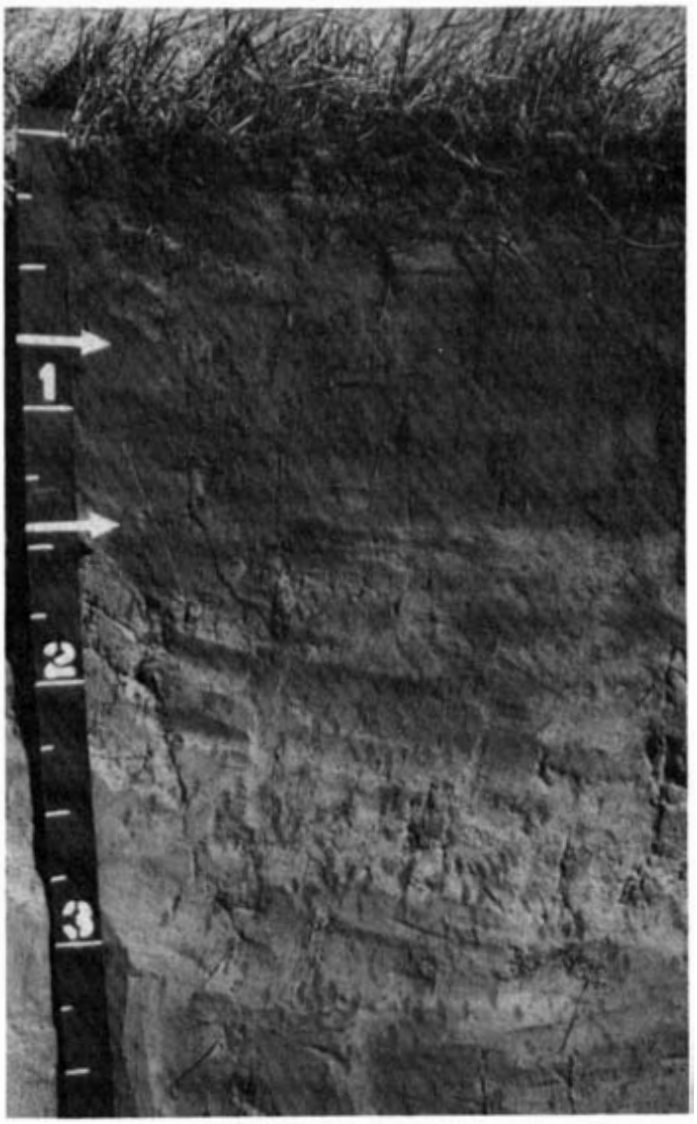


Figure 36.—Profile of Valentine fine sand. This sandy soil is the most common soil in the Nebraska Sandhills area. The scale is in feet.

Valentine soils are adjacent to Boelus, Dunday, Els, Ipage, Simeon, Tryon, and Whitelake soils. Boelus, Dunday, Simeon, and Wewela soils are in similar positions on the landscape. Boelus soils have loamy underlying material. Dunday soils have a mollic epipedon. Simeon soils are more than 35 percent medium and coarse sand and as much as 15 percent by volume gravel. Wewela soils contain more clay and have bedrock at a depth of 20 to 40 inches. Els, Ipage, and Tryon soils are in lower positions on the landscape. Els soils are somewhat poorly drained. Ipage soils have mottles at a depth of less than 40 inches. Tryon soils are poorly drained and very poorly drained.

Typical pedon of Valentine fine sand, rolling, 200 feet north and 50 feet west of the southeast corner of sec. 5, T. 27 N., R. 14 W.

A1—0 to 5 inches; grayish brown (10YR 5/2) fine sand, dark grayish brown (10YR 4/2) moist; weak fine granular structure; loose; slightly acid; clear smooth boundary.
AC—5 to 9 inches; light brownish gray (10YR 6/2) fine sand, grayish brown (10YR 5/2) moist; single grained; loose; slightly acid; clear smooth boundary.
C—9 to 60 inches; pale brown (10YR 6/3) fine sand, brown (10YR 5/3) moist; single grained; loose; slightly acid.

Thickness of the solum ranges from 5 to 17 inches. The soil is fine sand, loamy fine sand, and sand that is less than 35 percent medium sand. The soil is medium acid to neutral throughout the profile.

The A horizon has value of 4 through 6 (3 through 5 moist) and chroma of 2. The AC horizon has value of 5 through 7 (4 through 6 moist) and chroma of 2 or 3. The C horizon has value of 5 through 7 (4 through 6 moist) and chroma of 2 through 4.

Verdel series

The Verdel series consists of deep, well drained, slowly permeable soils on stream terraces. These soils formed in clayey alluvium derived from dark shale. Slope ranges from 0 to 2 percent.

Verdel soils are adjacent to Labu, Lynch, Sansarc, and Trent soils. Labu, Lynch, and Sansarc soils are on uplands above the Verdel soils. Labu and Lynch soils have bedded shale at a depth of 20 to 40 inches. Sansarc soils have bedded shale at a depth of 4 to 20 inches. Trent soils are in similar positions on the landscape and contain less clay in the subsoil.

Typical pedon of Verdel silty clay loam, 0 to 2 percent slopes, 2,200 feet west of the northeast corner of sec. 2, T. 33 N., R. 14 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark gray (10YR 3/1) moist; weak fine granular structure; hard, friable; slightly acid; abrupt smooth boundary.
A12—6 to 12 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; moderate medium granular structure parting to moderate fine granular; very hard, firm; slightly acid; clear smooth boundary.
B1—12 to 17 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium and fine subangular blocky structure; very hard, firm; neutral; clear smooth boundary.
B21—17 to 26 inches; dark grayish brown (2.5Y 4/2) silty clay, very dark grayish brown (2.5Y 3/2) moist; moderate medium subangular blocky structure parting to moderate fine angular blocky; very hard, firm; neutral; clear smooth boundary.
B22—26 to 34 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure parting to moderate medium angular blocky; very hard, firm; few fine calcium carbonate accumulations; strong effervescence; moderately alkaline; clear smooth boundary.
C—34 to 60 inches; olive gray (5Y 5/2) silty clay, olive gray (5Y 4/2) moist; moderate coarse prismatic structure; very hard, firm; common medium and fine calcium carbonate accumulations; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 25 to 55 inches. Depth to carbonates ranges from 20 to 35 inches. The mollic epipedon ranges from 20 to 30 inches in thickness and includes part of the B horizon.

The A horizon has hue of 10YR or 2.5Y, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silty clay loam, but the range includes silty clay. The A horizon is slightly acid or neutral. The B horizon has hue of 10YR, 2.5Y, or 5Y; value of 4 or 5 (3 or 4 moist); and chroma of 2 through 4. It is clay or silty clay. The B horizon is neutral through moderately alkaline. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6 (4 or 5 moist), and chroma of 2 or 3. It is silty clay or clay. The C horizon is moderately alkaline.

Wewela series

The Wewela series consists of moderately deep, well drained soils on uplands. Permeability is moderate in the loamy material and slow in the underlying clayey material. Wewela soils formed in loamy, windblown

material deposited over clayey material weathered from dark shale. Slope ranges from 0 to 6 percent.

Wewela soils are adjacent to Anselmo, Dunday, Elsmere, Ipage, Labu, Paka, Pivot, Simeon, and Valentine soils. Anselmo, Dunday, Ipage, Paka, Pivot, Simeon, and Valentine soils are higher on the landscape. The deep Anselmo soils contain less clay in the subsoil and underlying material. Dunday, Ipage, Pivot, Simeon, and Valentine soils are sandy and do not have shale within a depth of 40 inches. Paka soils are deep and formed in material weathered from siltstone. Labu soils do not have loamy material in the upper part of the profile.

Typical pedon of Wewela fine sandy loam, 0 to 2 percent slopes, 700 feet north and 300 feet east of the southwest corner of sec. 35, T. 32 N., R. 10 W.

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

B2t—8 to 16 inches; light olive brown (2.5Y 5/4) sandy clay loam, olive brown (2.5Y 4/4) moist; weak medium and fine subangular blocky structure; hard, friable; slightly acid; clear smooth boundary.

IIB3—16 to 26 inches; light brownish gray (2.5Y 6/2) and light yellowish brown (2.5Y 6/4) clay, grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/4) moist; moderate medium and fine angular blocky structure; hard, firm; few fine segregations of lime; neutral; gradual wavy boundary.

IIC1—26 to 38 inches; light yellowish brown (2.5Y 6/4) and brownish yellow (10YR 6/8) shaly clay, light olive brown (2.5Y 5/4) and yellowish brown (10YR 5/8) moist; moderate coarse subangular blocky structure; hard, firm; 20 percent shale fragments; few medium and fine segregations of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

IICr—38 to 60 inches; light yellowish brown (2.5Y 6/4) and yellow (10YR 7/6) bedded shale, light olive brown (2.5Y 5/4) and brownish yellow (10YR 6/6) moist; platy; common, medium, and fine segregations of lime; moderately alkaline.

Thickness of the solum ranges from 20 to 33 inches. Thickness of the mollic epipedon ranges from 7 to 10 inches. Depth to free carbonates ranges from 18 to 30 inches. Depth to bedded shale ranges from 20 to 40 inches.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is fine sandy loam, loam, or loamy fine sand 7 to 10 inches thick. The A horizon is slightly acid or neutral. The B2t horizon has hue of 10YR or 2.5Y, value of 5 or 6 (3 or 4 moist), and chroma of 2 through 4. It is sandy clay loam or clay loam. The B2t horizon is slightly acid or neutral. The IIB3 horizon has hue of 10YR or 2.5Y, value of 5 or 6 (4 or 5 moist), and chroma of 2 through 4. It is clay or silty clay. The IIC and IICr horizons have hue of 10YR or 2.5Y, value of 5 through 7 (4 through 6 moist), and chroma of 2 through 8. The IIC horizon is clay or shaly clay, and the IICr horizon is bedded shale. Segregated lime is common. The IIC and IICr horizons are neutral through moderately alkaline.

Whitelake series

The Whitelake series consists of deep, moderately well drained soils that formed in sandy and loamy sediment on stream terraces. Permeability is slow in the subsoil and moderate in the underlying material. Slope ranges from 0 to 2 percent. Whitelake soils are strongly alkaline or very strongly alkaline.

Whitelake soils in Holt County have less clay in the subsoil and have a thinner solum than is defined for the range of the series. These differences do not alter their usefulness or behavior. Whitelake soils in Holt County are mapped only in complex with Libory soils.

Whitelake soils are commonly adjacent to Dunday, Ipage, Libory, and Lute soils. Dunday, Ipage, and Libory soils are higher on the landscape. Dunday and Ipage soils are sandy throughout. Dunday soils are somewhat excessively drained. Libory soils have sandy material over silty material and are not affected by sodium. Lute soils are lower on the landscape and are somewhat poorly drained.

Typical pedon of Whitelake loamy fine sand, from an area of Libory-Whitelake loamy fine sands, 0 to 3 percent slopes, 2,000 feet south and 1,400 feet east of the northwest corner of sec. 11, T. 25 N., R. 12 W.

A1—0 to 6 inches; dark gray (10YR 4/1) loamy fine sand, black (10YR 2/1) moist; weak fine granular structure; soft, very friable; neutral; clear smooth boundary.

A2—6 to 8 inches; gray (10YR 5/1) loamy fine sand, very dark gray (10YR 3/1) moist; single grained; loose; mildly alkaline; abrupt wavy boundary.

B2t—8 to 18 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; moderate, coarse, columnar prismatic structure; very hard, friable; strongly alkaline; violent effervescence; clear wavy boundary.

C1ca—18 to 28 inches; light gray (10YR 7/2) fine sandy loam, pale brown (10YR 6/3) moist; weak, coarse, prismatic structure parting to weak medium and fine subangular blocky; hard, friable; few carbonate concretions; very strongly alkaline; violent effervescence; gradual smooth boundary.

C2ca—28 to 60 inches; light gray (10YR 7/2) very fine sandy loam, pale brown (10YR 6/3) moist; few fine faint yellowish brown (10YR 5/6) mottles; massive; soft, very friable; few carbonate concretions; moderately alkaline; violent effervescence.

Thickness of the solum ranges from 12 to 25 inches. Depth to carbonates ranges from 6 to 20 inches. Thickness of the mollic epipedon ranges from about 7 to 20 inches. The A1 and A2 horizons range from neutral to mildly alkaline, and the B2t horizon and C horizon range from moderately alkaline to very strongly alkaline.

The A1 horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is loamy fine sand or fine sandy loam. The A2 horizon has value of 5 or 6 (3 or 4 moist) and chroma of 1 or 2. It is loamy fine sand or fine sandy loam. The B2t horizon has value of 5 or 6 (4 or 5 moist) and chroma of 2 or 3. It is fine sandy loam or loam averaging less than 18 percent clay. The C horizon has hue of 2.5Y or 10YR, value of 5 through 7 (4 through 6 moist) and chroma of 2 or 3. Mottles and carbonate accumulations are common in the C horizon.

formation of the soils

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

Parent material affects the kind of soil profile that is formed more than any of the other factors involved. Most of Holt County is covered by wind- and water-laid, quartzitic sands that are extremely resistant to weathering and soil formation. Most of the soils in the county have developed over unconsolidated deposits laid down by wind or water. Climate and plant and animal life act on the parent material and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. Usually, long periods of time are needed to change the parent material into a soil profile that has well defined horizons. In most of the soils in Holt County, the distinguishing characteristics are the result of parent material and drainage rather than other soil forming factors.

The factors of soil formation are closely interrelated in their effect on the soil. 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

Parent material is the unconsolidated earth material from which a soil forms. It is largely responsible for the chemical and mineralogical composition of the soil. The soils of Holt County formed in material transported by wind and water and in material weathered from the underlying geologic formation.

The Pierre Shale is the oldest material exposed in Holt County. It is on side slopes along the Niobrara River and its tributaries. Most of the Pierre Shale is black to gray, clayey shale that contains layers of bentonite, limestone, and chalky shale. The moderately deep Labu soils and shallow Sansarc soils formed in this material. In places, a thin layer of loamy eolian material mantles the Pierre Shale. Wewela soils formed in this material. On some foot slopes and stream terraces, the interaction of water and gravity has influenced the deposition of clayey material. The soils formed are deep, dark, and have well developed horizons. Verdel soils formed in this material. The Mobridge member of the Pierre Shale formation is exposed on lower side slopes in a few places. It consists of beds of platy, calcareous, clayey shale and chalky shale. If exposed, this material weathers to a yellowish orange or yellowish brown. Soil weathered from this material is high in content of lime and gypsum. The moderately deep Lynch soils and shallow Bristow soils formed in this material.

The Ogallala Formation overlies the Pierre Shale. This formation is exposed on slopes along tributaries of the Niobrara River, on the Holt Table, and on south-facing slopes immediately north of the Elkhorn River. The Ogallala Formation consists largely of siltstone, sandstone, and fine grained sand. Consolidation of the sediments varies from packed to cemented. Ogallala sediment ranges from fine sand to sandy clay loam and some of it is extremely calcareous. Much of this material has a thin cover of eolian sand or loess. The moderately deep Brunswick soils and the deep Paka soils formed in this material. The shallow Tassel soils formed in bedded sandstone.

Quaternary deposits, consisting of sand and gravel, rest upon the Ogallala Formation. The sand and gravel was deposited by streams flowing from the west during the Pleistocene age. South of the Elkhorn River, the Quaternary deposits are buried by a thick layer of sandy and loamy alluvium. North of the Elkhorn River the deposits are covered by thin layers of eolian sands and silts and sandy or loamy alluvium. Bazile, Jansen, Meadin, O'Neill, Pivot, and Simeon soils formed in these materials.

Wind-deposited sand is the most extensive of the soil forming materials in the county. The sand is of mixed mineralogy; quartz and feldspar are the principal minerals. Thickness of the sand ranges from a few inches to several hundred feet. In places, the wind has sorted out the fine soil particles and left mostly fine sand in the form of dunes. Valentine soils formed in coarse eolian sand in the sandhills and are mostly gently rolling to hilly. Anselmo and Dunday soils formed in sandy and loamy eolian material. Boelus, Dunn, Libory, and Whitelake soils formed in eolian sand that overlies loamy sediment. Whitelake soils are high in content of sodium.

There are no extensive loess deposits in Holt County. In most places, the loess occurs only as a thin layer. It generally overlies Pleistocene sand and gravel, Ogallala sediment, or alluvium. Fillmore, Nora, and Trent soils formed in loess. Loretto soils formed in loess mixed with eolian sand. Josburg soils formed in loess material that overlies loamy alluvium.

Alluvium was deposited by water and consists of clay, silt, sand, and gravel washed from other areas and deposited on bottom lands and stream terraces. The deposits range in thickness from a few feet to 25 feet or more. Soil formation is slight in the alluvial sediment, and the texture of the soil is closely related to the texture of its parent material. Soils on bottom lands in the subirrigated valleys south of the Elkhorn River formed mostly in sandy alluvium. Large areas are underlain at a shallow depth by ground water, which keeps the underlying material continually wet and which periodically rises in places enough to waterlog the entire soil profile. The Elsmere and Els soils are somewhat poorly drained; Tryon, Loup, and Gannett soils are poorly drained or very poorly drained; and Marlake soils are very poorly drained. All of these soils formed in sandy alluvium. Lawet, Lamo, Lex, and Ord soils formed in loamy alluvium or loamy over sandy alluvium and are somewhat poorly drained. Lute and Selia soils formed in loamy and sandy alluvium that is high in sodium content. They are somewhat poorly drained. In places, the sandy alluvium has been reworked by the wind. The moderately well drained Ipage soils formed in this material. The soils on the high bottom lands are well drained to excessively drained. Cass and Nimbro soils formed in loamy alluvium, and Inavale soils formed in sandy alluvium. The most recent alluvium is on bottom lands along drainageways that are subject to occasional flooding. Barney and Boel soils formed in stratified sandy alluvium. Barney soils are poorly drained, and Boel soils are somewhat poorly drained.

climate

The climate of Holt County is continental and subhumid. There are wide seasonal variations in temperature and moisture. The mean annual temperature is about 49 degrees F, and the average annual rainfall is about 22 inches. The average growing season is about 150 days.

Climate directly affects soil formation through rainfall, changes in temperature, and the working of wind. As rainwater moves through the soil, it carries nutrients, clay, and organic matter from the surface horizon to the subsoil or underlying material. As soils develop, precipitation infiltrating the soil leaches free lime from the profile. Soil material is also shifted, sorted, and reworked by running water. Temperature and moisture affect the speed of chemical weathering. Alternate freezing and thawing and wetting and drying speed the chemical and mechanical weathering processes and improve the physical condition of the soil by loosening and mixing the material.

Wind transfers soil material from one place to another. The extensive deposits of eolian sand in Holt County are examples of the importance of wind as an agent in the deposition of soil material. The hummocky topography of the Valentine soils can be attributed to wind activity. Also, wind mixes and sorts the surface layer, causing changes in physical properties of the soil. Hot wind in the summer has a drying effect on soils.

Climate affects soils indirectly through the amount and kind of vegetation and animal life that is sustained. Biological activity increases when temperature and moisture conditions are favorable. The accumulation of organic matter and the darkening of the surface layer are promoted by the decomposition of vegetation. This decomposition is brought about by the animal and biological activity in the soil, which helps convert plant remains into humus.

plant and animal life

When the weathering and deposition processes slow down, grasses and other plants take root. As soon as vegetation is established, many kinds of animals and organisms inhabit the soil material to make use of the food provided by the plants. Plants and animals live on or in the soil and influence its physical and chemical properties through the organic matter they provide. The other soil forming factors affect the kind and amounts of vegetation and animal life that live on any given soil.

The soils of Holt County formed under mid and tall grasses. The grasses provide organic matter as the plants and their roots decompose. The fibrous roots of grasses penetrate the soil to a depth of several feet and improve the porosity and structure of the soil. Plant roots take minerals from the lower part of the soil; these nutrients add fertility to the soil as the plants decay. Plants keep the soil porous and open to air and water movement, thus encouraging the activity of bacteria, earthworms, and burrowing animals. The dead roots and undecomposed organic matter are attacked by micro-organisms to produce humus and other mineral nutrients that are available to living plants.

Because some bacteria take nitrogen from the air and use it for their own growth, the nitrogen is available for use by plants when the bacteria die. Micro-organisms and animal activity increase with the increase in organic matter in the well drained soils. The wetter soils are colder and more poorly aerated. Organic matter decays more slowly because living organisms are less numerous. Insects, earthworms, and small burrowing animals stir the soil and mix it with fresh nutrients. This hastens the formation of organic matter.

Man greatly affects plant and animal life by his management of the soil. Man's activity will continue to affect the direction and rate of soil formation.

relief

Relief, or lay of the land, influences soil formation through its effect on runoff, drainage, and erosion. It controls the movement of water on the surface. The degree of slope, shape of the surface, and other features of relief affect each soil that develops. Relief influences the moisture content in soil and the erosion from the surface. Steep soils have a thin surface layer and indistinct horizons. Because the steep slopes cause rapid runoff, so that only a small amount of water enters the soil, plants grow slowly and soil formation proceeds slowly. If there is too much runoff, erosion removes the surface layer almost as fast as it forms.

In the sandhills, little or no runoff occurs because of the rapid intake rate. The soils are excessively drained, and horizons are weakly formed and indistinct. The coarse sandy material is highly resistant to chemical weathering.

The nearly level and gently sloping soils normally have stronger development and more distinct horizons than similar soils on steeper slopes. They absorb moisture, and percolation is deeper into the profile. Low and flat topography means that extra moisture is added to the soil. The extra moisture is evident in a thick, dark surface layer, more horizon development, and more leaching of lime. Normally, as the slope increases, the thickness of the soil profile decreases. On nearly level areas or in depressions where there is little or no runoff, a claypan may develop in the subsoil.

Soils on bottom lands and stream terraces have very little relief. Some bottom land soils have a high water table that affects decay of organic matter, soil temperature, and alkalinity. Other bottom land soils are subject to flooding, and there is continuous deposition of sediment.

time

Time is required for soil formation. The length of time needed for a soil to form depends on the influence of the other four soil forming processes, especially parent material. Soils that have been in place only a short time show little or no horizon development. Soils that have been in place for a long time have well expressed horizons. Mature soils are believed to have reached an equilibrium with their environment. If land use, irrigation, or some other factor changes the environment, the soil establishes a new equilibrium to meet the new environment.

Soils formed in residuum develop more slowly than soils formed in unconsolidated parent material. The weathering of the residuum and soil formation take place at the same time, but the process is very slow. The soils formed in the Pierre Shale and Ogallala sediment are the oldest and have been in place long enough for mature genetic profiles to have developed. The loess, alluvium, and eolian material deposited on the Pleistocene sands and gravels on the Holt Table are among the older parent materials in the county. Soils formed in these materials have been in place long enough for genetic profiles to have developed and for horizons to have accumulated to some thickness. Bazile, Jansen, and Trent soils are mature soils that have a well developed subsoil.

The eolian sands and alluvium have not been in place long enough for mature soils to develop. Soils in these deposits are young, immature soils and have little or no subsoil development because of the brief time their parent materials have been in place. In alluvial areas subject to flooding, deposition is still occurring. Valentine, Inavale, and Boel soils are some of the youngest soils in the county.

references

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) Bower, C.A. 1959. Chemical amendments for improving sodium soils. U.S. Dep. Agric., Agriculture Research Serv. Inform. Bull. No. 195, 9 pp., illus.

(4) Ehlers, Paul, Glenn Viehmeyer, Robert Ramig, and E.M. Brouse. 1952. Fertilization and improvement of native subirrigated meadows in Nebraska. Univ. of Nebraska Coll. of Agric. Circ. No. 92, 15 pp., illus.

(5) Reed, E.C. 1944. Groundwater survey of area north of O'Neill, Holt County, Nebraska. Univ. of Nebraska Conserv. and Survey Div. Bull. No. 2, 26 pp., illus.

(6) United States Department of Agriculture Bureau of Chemistry and Soils and University of Nebraska Conservation and Survey Division. 1938. Soil survey of Holt County, Nebraska, 38 pp., illus.

(7) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962]

(8) United States Department of Agriculture. 1966. Soil survey laboratory data and descriptions for some soils of Nebraska. Soil Surv. Invest. Report No. 5., 233 pp.

(9) United States Department of Agriculture. 1967. Appraisals of potentials for outdoor recreation developments for Holt County, Nebraska. Soil Conserv. Serv., 21 pp., illus.

(10) United States Department of Agriculture. 1971. Irrigation guide for Nebraska. Soil Conserv. Serv. (loose-leaf).

(11) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

(12) United States Salinity Laboratory. 1954. Diagnosis and improvement of saline and alkali soils. U.S. Dep. Agric. Handbook No. 60, 160 pp., illus.

(13) United States Salinity Laboratory. 1958. Salt problems in irrigated soils. U.S. Dep. Agric. Inform. Bull. 190, 12 pp., illus.

(14) Yost, Nellie Snyder. 1976. Before today: The history of Holt County, Nebraska. Miles Publishing Co., O'Neill, Neb., 509 pp., illus.

glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Blowout. A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Bottom land. The normal flood plain of a stream, subject to flooding.

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

Catsteps. Very small, irregular terraces on steep hillsides, especially in pasture, formed by the trampling of cattle or the slippage of saturated soil.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard, compact layers to depths below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse textured soil. Sand or loamy sand.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and leaves all or part of the crop residue on the surface throughout the year.

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

Loose.—Noncoherent when dry or moist; does not hold together in a mass.
Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.
Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.
Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.
Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.
Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Depth, soil. The total thickness of weathered soil material over bedrock or mixed sand and gravel. In this soil survey, the classes of soil depth are—

	Inches
Very shallow	0 to 10
Shallow	10 to 20
Moderately deep	20 to 40
Deep	more than 40

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the removal of water from the soil. Drainage classes are determined on the basis of an overall evaluation of water removal as influenced by climate, slope, and position on the landscape. Precipitation, runoff, amount of moisture infiltrating the soil, and rate of water movement through the soil affect the degree and duration of wetness. Seven classes of natural soil drainage are recognized:
Excessively drained.—Water is removed from the soil very rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow, very porous, or steep, or a combination of these.
Somewhat excessively drained.—Water is removed from the soil rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow or moderately deep, very porous, or steep, or a combination of these.
Well drained.—Water is removed from the soil so readily that the upper 40 inches generally does not have the mottles or dull colors related to wetness.
Moderately well drained.—Water is removed from the soil so slowly that the upper 20 to 40 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.
Somewhat poorly drained.—Water is removed from the soil so slowly that the upper 10 to 20 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.
Poorly drained.—Water is removed so slowly that either the soil is periodically saturated or the upper 10 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.
Very poorly drained.—Water is removed from the soil so slowly that free water is at or on the surface most of the time. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Drainage, surface. Runoff, or surface flow of water, from an area.

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

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.
Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.
Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:
O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.
A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.
B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.
C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

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

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow

infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Moderately coarse textured soil. Sandy loam and fine sandy loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. The organic fraction of the soil. It includes plant and animal residue at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population. It is commonly determined as those organic materials that accompany the soil material when it is put through a 2-millimeter sieve. In this soil survey, the ratings for organic matter content are—

	Percent
Moderate	2.0 to 4.0
Moderately low	1.0 to 2.0
Low	0.5 to 1.0
Very low	less than 0.5

Parent material. The unconsolidated organic and mineral material in which soil forms.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor filter (in tables). Because of rapid permeability or an impermeable layer near the surface, the soil may not adequately filter effluent from a waste disposal system.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

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

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

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002

millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance. In this survey the classes of slope are—

	Percent
Nearly level	0 to 2
Level to very gently sloping	0 to 3
Very gently sloping	1 to 3
Gently sloping	2 to 6 and 3 to 6
Strongly sloping	6 to 9 and 6 to 11
Moderately steep	11 to 17
Steep	17 to 30
Very steep	more than 30

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

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

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stratified. Arranged in strata or layers. Refers to geologic material. Layers in soil that result from the processes of soil formation are called horizons. Those inherited from the parent material are called strata.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

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

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A1, A2, A3) below the surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

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

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.