United States
Department of
Agriculture

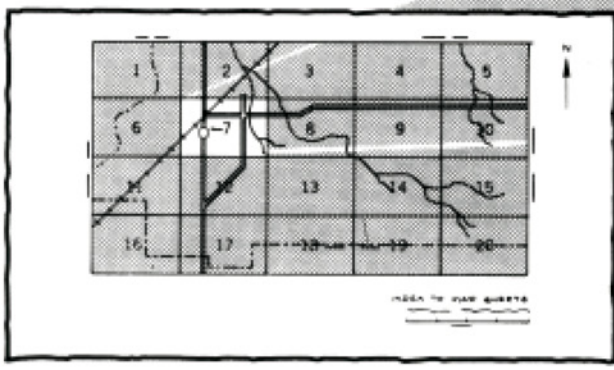
Soil
Conservation
Service

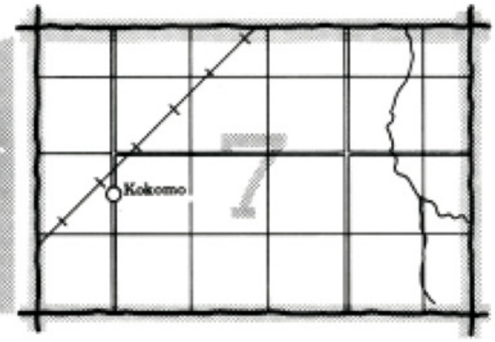
In cooperation with
University of Nebraska,
Conservation and Survey
Division

Soil Survey of Cass County Nebraska

HOW TO USE

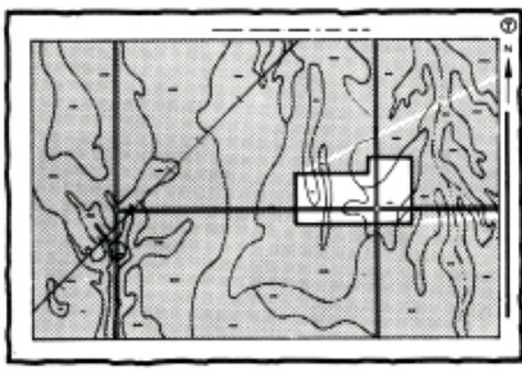
1. Locate your area of interest on the "Index to Map Sheets"

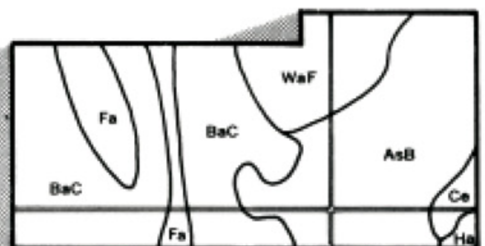




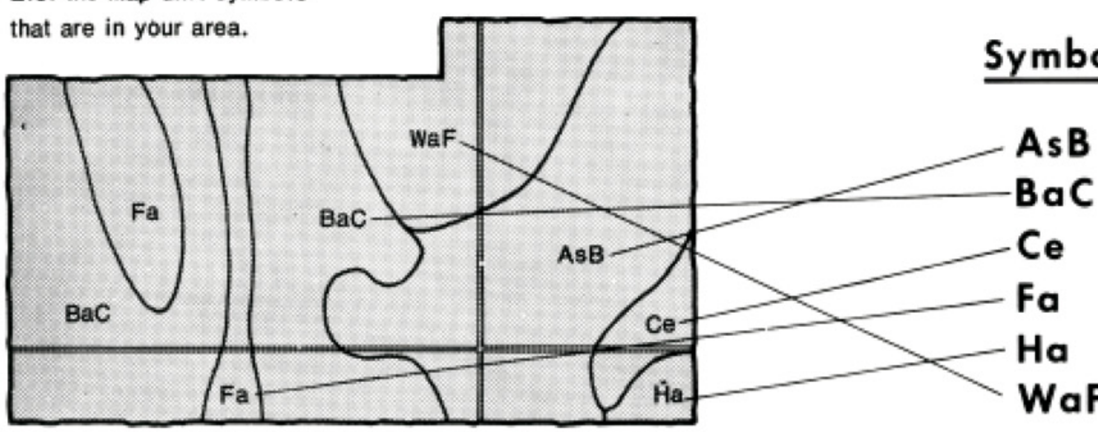
2. Note the number of the map sheet and turn to that sheet.

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



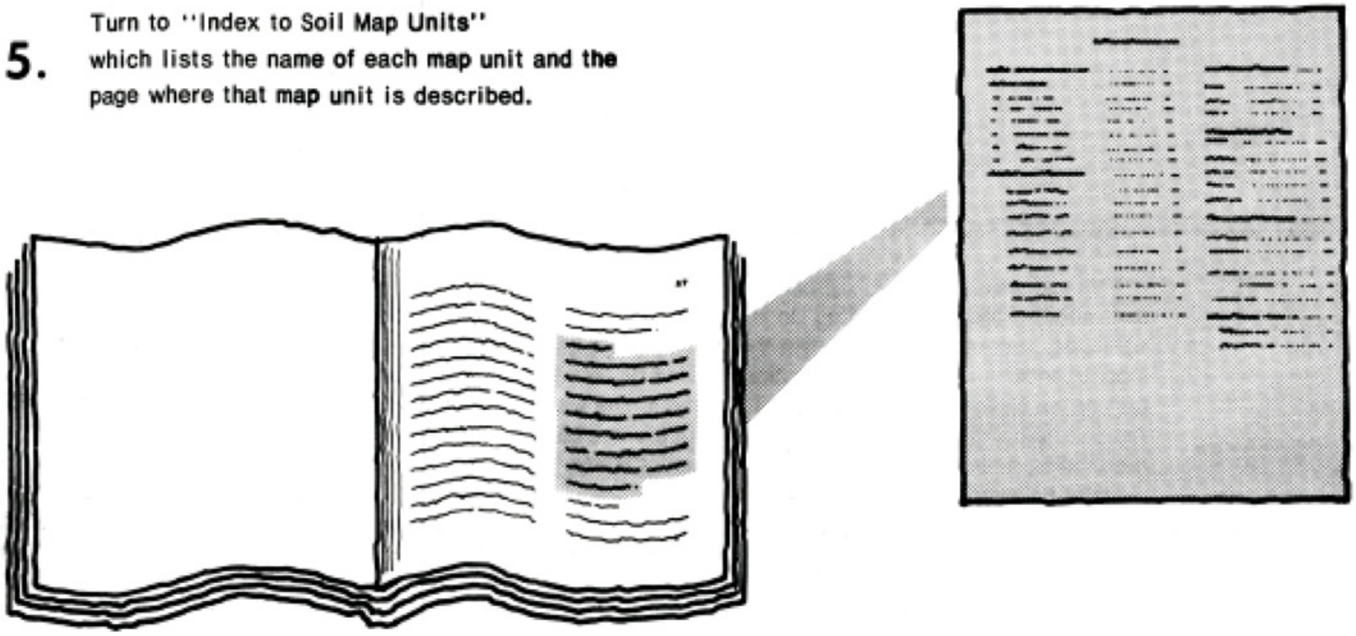


4. List the map unit symbols that are in your area.

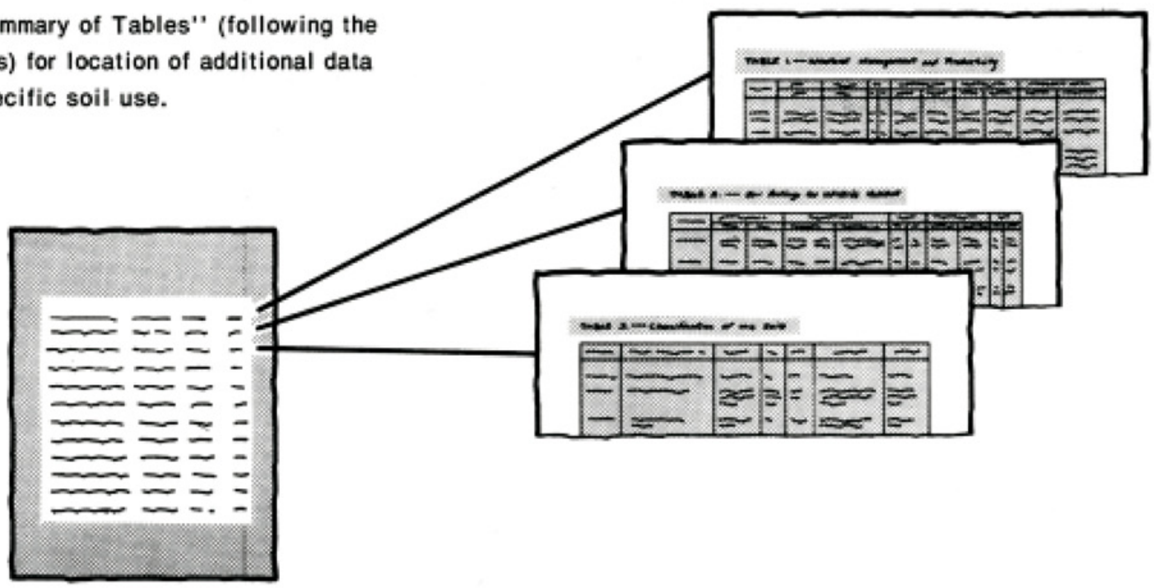


THIS SOIL SURVEY

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 other federal agencies; state agencies including the University of Nebraska, Conservation and Survey Division, and the Agricultural Experiment Stations; and local 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 Lower Platte South and the Nemaha Natural Resource Districts. Major fieldwork for this soil survey was completed in 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. The Lower Platte South Natural Resource District provided financial assistance for part of the fieldwork for this survey.

Cover: Because water erosion is a major hazard on Marshall soils, some farms on those soils have a complete conservation management system, including terraces, grass waterways, and contour farming.

Contents

Soil Series

Issued March 1984

Index to Map Units

Summary of Tables

Foreword

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

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to 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 or the Cooperative Extension Service.

A. E. Sullivan
State Conservationist
Soil Conservation Service

Soil Survey of
Cass County, Nebraska

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

Cass County is in southeastern Nebraska (fig. 1), south of the Platte River and west of the Missouri River at their juncture. Cass County has a total area of 360,960 acres, or approximately 564 square miles. Plattsmouth is the largest town and county seat.

Agriculture is the main industry in the county. Corn, soybeans, alfalfa, small grains, and grain sorghum are grown extensively. These crops provide feed for cattle and hogs as well as cash income. Quarrying is important, especially near the towns of Weeping Water and Louisville and along the Platte River.

Most of the soils in Cass County are silty. In a small area in the north-central part of the county, the soils are sandy, as are some soils on bottom lands. In a few areas of glacial till and on bottom lands, the soils are clayey. Most soils are deep over loess, glacial till, or alluvium, but a few are shallow over limestone or sandstone. The soils are somewhat excessively drained to very poorly drained and level or nearly level to very steep.

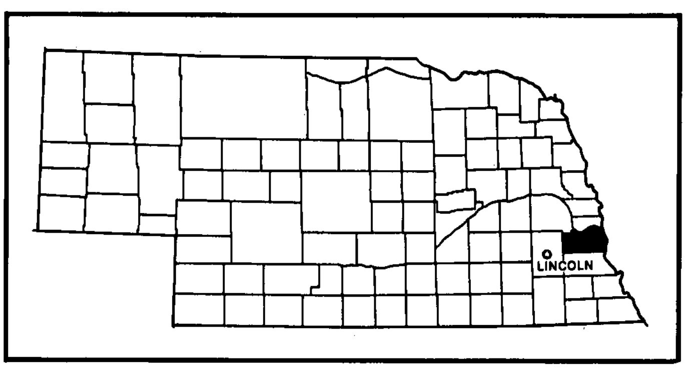

Figure 1.—Location of Cass County in Nebraska.

The major soils on the uplands formed in silty loess. The minor soils formed in glacial till and are loamy and clayey. Erosion by water is the main hazard on upland soils. Conserving water by controlling runoff and maintaining soil fertility are the main management concerns.

Soils in the stream valleys formed in alluvium or a mixture of alluvium and colluvium. Occasional flooding and wetness from the seasonal high water table are the main hazards on these bottom land soils. Maintaining fertility and controlling wind erosion are the main concerns in management.

The first soil survey of Cass County was published in 1913, and the second was published in 1941 (*5*). This survey updates the previous soil surveys and provides additional information and larger maps that show the soils in greater detail.

General Nature of the Area

This section provides general information about Cass County. It discusses history and development; climate; geology; ground water; physiography, relief, and drainage; business and transportation; and trends in farming.

History and Development

The first settlement in Cass County was made in 1853 just below the mouth of the Platte River. The county was established in 1855 and was named after Lewis Cass, who was Secretary of State during President Pierce's administration. By 1856, settlement had spread throughout the uplands.

The population of the county was 24,080 in 1890; 17,684 in 1930; and 20,297 in 1980. Most residents of the county earn their living by farming or in related industries.

Plattsmouth, the county seat, has a population of 6,371. Weeping Water and Louisville have populations of 1,143 and 1,036. Smaller towns and villages are located in various parts of the county. They provide local markets and distribution centers for farm supplies and produce.

Climate

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

Cass County is cold in winter and is quite hot with occasional cool spells in summer. Precipitation during the winter frequently comes as snowstorms. During the warm months it is chiefly showers, often heavy, when warm, moist air moves in from the south. Total annual rainfall is normally adequate for corn, soybeans, and small grains.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Weeping Water in the period 1951 to 1978. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 26 degrees F, and the average daily minimum temperature is 15 degrees. The lowest temperature on record, which occurred at Weeping Water on January 12, 1974, is -26 degrees. In summer the average temperature is 75 degrees, and the average daily maximum temperature is 87 degrees. The highest recorded temperature, which occurred on July 13, 1954, is 109 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 32 inches. Of this, 24 inches, or 75 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 18 inches. The heaviest 1-day rainfall during the period of record was 5 inches at Weeping Water on September 26, 1973. Thunderstorms occur on about 50 days each year, and most occur in summer.

The average seasonal snowfall is 29 inches. The greatest snow depth at any one time during the period of record was 33 inches. An average of 17 days have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 60 percent in winter. The prevailing wind is from the south-southeast. Average windspeed is highest, 12 miles per hour, in spring.

Tornadoes and severe thunderstorms strike occasionally. These storms are local and of short duration and result in sparse damage in narrow belts. Hailstorms occur occasionally during the warmer part of the year in irregular patterns and in relatively small areas.

Geology

Rocks of Pennsylvanian age are the bedrock in Salt Creek valley, in the Platte River valley and on the adjacent bluffs, in the Missouri River valley, in eastern and southern Cass County, and in a narrow area running from the Salt Creek valley southeast of Greenwood to Wabash. Pennsylvanian limestone crops out and is quarried at numerous sites on the valley sides along the Platte and Missouri Rivers and Weeping Water Creek. Cement from the plant at Louisville, crushed rock for construction, and agricultural limestone are the principal products.

Sandstone and shale of the Dakota Group are the bedrock beneath most of the uplands. There are numerous small outcrops near Louisville and South Bend. Easily quarried sandstone was used in the early houses and town buildings. The stone available today is of minor commercial interest. Sand from some of the old quarry sites is used locally.

Unconsolidated sediments of Quaternary age overlie the bedrock. Kansan glacial till overlies the bedrock throughout most of the county and is at the surface on many valley sides, principally in the southwestern and south-central parts of the county. The till is moderately clayey with a few granite and quartzite boulders, some cobbles, and many pebbles. Illinoian age sediments consist of clayey to sandy alluvial material and Loveland Loess. These materials are on valley sides throughout the county. Peorian Loess covers the upper side slopes, ridgetops, and upland flats. It is pale brown, slightly clayey silt in the upper part grading downward to light gray, clayey silt with brown iron and manganese mottles and concretions.

The flood plains in the smaller valleys are dark colored, silty to clayey sediment washed from nearby uplands. An overwash of lighter colored material derived from erosion is present in many places. The Platte and Missouri River flood plains have a thin mantle of locally derived material over clayey, sandy, and gravelly sediment from sources upstream. Silty, clayey, or sandy sediment, and gravelly sediment in a few places, are at the surface. The flood plains of most small valleys are flooded one or more times each year, the larger valleys less frequently. The first bottoms of Salt Creek and the Platte and Missouri Rivers are flooded occasionally. The stream terraces are not subject to flooding from the streams, but runoff from adjacent uplands may cause local flooding of short duration on both first bottoms and terraces.

More information about the geology of Cass County can be found in specialized publications (*3, 4*).

Ground Water Supply

Wells in Cass County provide water for domestic use, livestock, and industry and, in places, for irrigation. Limestone of Pennysylvanian age, sandstone of the Dakota Group, Cretaceous rocks, and unconsolidated sediments of Quaternary age that mantle the bedrock are sources of ground water.

The Pennsylvanian rocks generally are a poor source of water. Most wells tapping these formations have small yields, and the water commonly is too mineralized.

The sandstone layers of the Dakota Group are moderately permeable, and those that are saturated can yield water. These rocks are an important source of water for domestic and industrial use.

Unconsolidated sediments of Quaternary age consist of till and other glacial deposits, wind-deposited silt, and alluvium. Of these, only alluvium is a significant source of water. It underlies the terraces and bottom lands in all of the larger valleys and also fills some ancient, now buried valleys. Alluvium consisting largely of sand or sandy gravel, as in the valleys of Salt Creek and the Platte and Missouri Rivers, can supply sufficient water for municipal and industrial uses and for irrigation. Elsewhere, yields generally are large enough for domestic and stock use. The water is usually of good quality, but in some wells the mineral content may exceed the accepted limits for certain uses. Sand lenses and pockets of sand and gravelly sand in the glacial deposits can provide small quantities of water; many farm wells in the county depend on this limited and somewhat unreliable source. The water quality varies from good (but hard) to very hard with the sulphate and iron content often exceeding accepted limits.

Physiography, Relief, and Drainage

Cass County lies in two physiographic areas. Approximately 75 percent of the county is in the Nebraska and Kansas Loess-Drift Hills. The rest is in the Iowa and Missouri Deep Loess Hills. The county can be divided into the valleys of the Missouri and Platte Rivers and the adjacent steep loess bluffs and hills; the loess uplands of the central, northern, and eastern parts; the loess-glacial till areas of the southwestern part; and the bottom lands along Salt Creek. The greatest local relief is between the Missouri bottom and the loess bluffs, where the elevation difference is 150 to 300 feet.

The level or nearly level valleys of the Missouri and Platte Rivers occupy a relatively small area of the county. They are cut by small drainageways from upland streams and in some places by old meanders. The loess bluffs and hills are moderately steep to very steep and are dissected by numerous short drainageways that run to the bottom lands.

The loessal uplands range from slightly concave to steep. The slightly concave areas are broad, nearly level ridgetops. Most of the uplands are a succession of narrow ridgetops, adjacent side slopes, and small stream valleys. The side slopes are gently sloping to steep, and the narrow ridgetops are nearly level to gently sloping. Several large streams, as well as numerous small streams, drain the upland area. The most prominent stream is the southeastward-flowing Weeping Water Creek.

The loess-glacial till areas consist of gently sloping, narrow ridgetops, gently sloping to steep side slopes, gently sloping to nearly level foot slopes, and narrow bottom lands. The main stream in this area, the North Fork of the Little Nemaha River, flows southeasterly.

The alluvial land along Salt Creek is level and nearly level. This area includes bottom lands and terraces. Salt Creek flows northeasterly. Callahan, Greenwood, and Dee Creeks flow into it from the south.

The average elevation of Cass County is about 1,200 feet above sea level. The range is from 1,360 feet at Eagle to 928 feet in the southeastern corner along the Missouri River. Plattsmouth has an elevation of 1,041 feet.

Business and Transportation

The production of cement, crushed rock and lime, and sand and gravel are the main manufacturing enterprises in Cass County. Several businesses sell fertilizer, seed, and farm machinery. Many businesses process feed for livestock or repair farm machinery.

Most cattle and hogs are shipped to Omaha for market. Dairy and poultry products are marketed locally and outside the county. Grain and feed products not used on the farm are sold at local elevators and shipped to other markets.

Cass County is traversed by several highways and several railroad lines. A barge depot at Rock Bluff provides access to the Missouri River. Air service is available at Lincoln and Omaha.

Trends in Farming

Farming has been of major importance in Cass County since the county was settled. There were 1,086 farms in 1969 and 965 in 1978. The reduction can be accounted for by urbanization around Plattsmouth and along the

Platte River, by increases in farm size, and by increased industrialization. Urban land, roads, quarries, and related uses took up 27,777 acres of Cass County in 1969.

For many years corn was the main cultivated crop in the county, but in recent years soybean production has outstripped corn. In 1971, 94,500 acres of corn was harvested and in 1978, 66,800 acres. Soybeans were harvested on 31,100 acres in 1971 and on 74,600 acres in 1978. Acreages of grain sorghum, oats, and hay increased only slightly from 1971 to 1978. Rye decreased, but traditionally there has not been much planted. Winter wheat increased from 20,700 acres in 1971 to 30,000 acres in 1978.

Irrigation is of minor importance, but is becoming increasingly important. A total of 2,800 acres was irrigated in 1974 and 6,000 acres in 1978. In 1971, 430 acres of corn was irrigated and in 1978, 3,000 acres. Soybeans went from no irrigation in 1971 to 500 acres in 1978.

Use of fertilizer in the county is variable and seems to depend on conditions (economic, weather, etc.). In 1970-71, approximately 23,000 tons of fertilizer was sold in Cass County. This decreased to approximately 17,500 tons in 1976-77 and increased to 18,000 tons in 1977-78.

Numbers of livestock have generally been decreasing. In 1971, the total number of cattle on farms was 60,100 compared to 45,000 in 1978, while the number on farms and in feedlots dropped from 108,000 to 87,900 in the same period. Hog numbers showed a slight increase from 23,700 in 1971 to 24,400 in 1978. Sheep declined from 1,650 to 900 in the same period.

How This Survey Was Made

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

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

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

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

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

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

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

Some soil boundaries and soil names may not fully match those in surveys of adjoining areas that were published at an earlier date. This is the result of refinements in series concepts, differences in defining map units, and improvements in the soil classification system.

Map Unit Composition

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

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

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation to precisely define and locate the soil is needed to plan for intensive uses in small areas.

General Soil Map Units

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

Poorly drained to excessively drained, silty, clayey, and sandy soils on bottom lands and foot slopes

These deep, nearly level to gently sloping soils are sandy, silty, and clayey. They are mainly on bottom lands and foot slopes along drainageways.

These soils make up about 11 percent of the county. Most of the acreage is cropped to corn, soybeans, and grain sorghum. Some of the cropped areas are irrigated. The main limitations are wetness caused by the high water table in spring and droughtiness after the water table recedes late in summer. Flooding is also a problem. Maintaining grasses in good condition and improving the fertility of the cultivated soils are important.

1. Kennebec-Colo-Zook Association

Deep, nearly level, moderately well drained to poorly drained, silty and clayey soils that formed in alluvium; on bottom lands

This association is mainly on flat bottom lands of Salt Creek and includes the foot slopes of the adjacent terraces and uplands (fig. 2).

This association occupies 3,050 acres, or about 1 percent, of the county. It is about 34 percent Kennebec soils, 28 percent Colo soils, 18 percent Zook soils, and 20 percent minor soils.

Kennebec soils are on the higher parts of the bottom lands. They are nearly level and moderately well drained. The surface layer is very dark gray, friable silt loam about 6 inches thick. The subsurface layer is black, friable silt loam about 27 inches thick. The next layer is black, friable silt loam about 9 inches thick. The underlying material is stratified black, very dark gray, and very dark grayish brown silt loam to a depth of 60 inches.

Colo soils are on bottom lands. They are nearly level and somewhat poorly drained or poorly drained. The surface layer is very dark gray, friable silty clay loam about 7 inches thick. The subsurface layer is friable silty clay loam about 19 inches thick; the upper part is black, and the lower part is very dark gray. The subsoil is very dark gray, firm silty clay loam about 11 inches thick. The underlying material is black silty clay loam to a depth of 60 inches.

Zook soils are on the lower parts of the bottom lands. They are nearly level and poorly drained. The surface layer is black, friable silty clay loam or silty clay about 6 inches thick. The subsurface layer is about 26 inches thick; the upper part is black, firm silty clay, and the lower part is very dark gray, very firm silty clay. The subsoil is very dark gray and dark gray, very firm silty clay about 12 inches thick. The underlying material is very dark gray silty clay to a depth of 60 inches.

The most important minor soils are Nodaway soils, which are adjacent to the drainageways. Nodaway soils are moderately well drained and are occasionally or frequently flooded.

Farms in this association are mainly the cash grain type. Grain sorghum, soybeans, and corn are the principal crops. Some soils are irrigated where ground water or streamflow is adequate. Some of the grain is used on the farms as cattle and hog feed. Grain for cash sale is marketed mainly at local elevators.

Flooding is common during years of above-normal precipitation. Soil wetness from the seasonal high water table affects planting and tilling.

Soils in this association have severe limitations for dwellings and sanitary facilities because of the flooding and wetness.

2. Nodaway-Judson-Colo Association

Deep, nearly level to gently sloping, well drained to poorly drained, silty soils that formed in alluvium and colluvium; on bottom lands and foot slopes

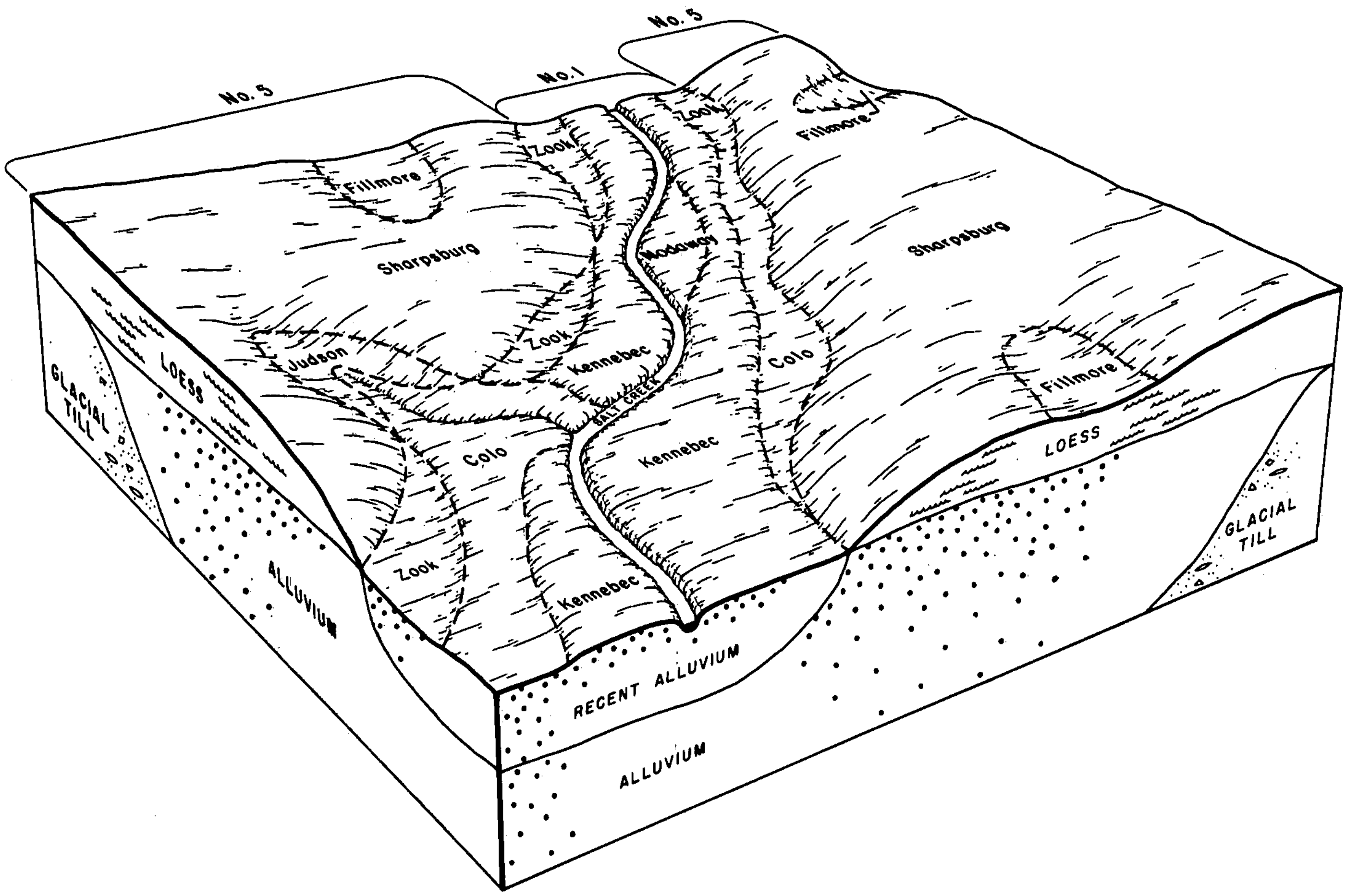

Figure 2.—Typical pattern of soils and underlying material in the Kennebec-Colo-Zook (No. 1) and Sharpsburg-Fillmore (No. 5) associations.

This association is mainly on bottom lands of major creeks and gently sloping foot slopes of the uplands.

This association occupies 20,430 acres, or about 6 percent, of the county. It is about 44 percent Nodaway soils, 19 percent Judson soils, 18 percent Colo soils, and 19 percent minor soils.

Nodaway soils are commonly adjacent to drainageways. They are nearly level and moderately well drained. The surface layer is very dark grayish brown, friable silt loam about 7 inches thick. The underlying material is stratified very dark grayish brown and dark grayish brown silt loam to a depth of 60 inches.

Judson soils are at high positions in the valleys and on foot slopes of the uplands. They are nearly level to gently sloping and well drained. The surface layer is very dark brown, friable silt loam about 7 inches thick. The subsurface layer is about 22 inches thick. The upper part of the subsurface layer is very dark brown, friable silt loam; the middle part is very dark grayish brown, friable silty clay loam; and the lower part is dark brown, friable silty clay loam. The subsoil is friable silty clay loam about 20 inches thick. It is dark brown in the upper part and dark yellowish brown in the lower part. The underlying material is dark yellowish brown silty clay loam to a depth of 60 inches.

Colo soils are on lower parts of the landscape. They are nearly level and are somewhat poorly drained or poorly drained. The surface layer is very dark gray, friable silty clay loam about 7 inches thick. The subsurface layer is friable silty clay loam about 19 inches thick; the upper part is black, and the lower part is very dark gray. The subsoil is very dark gray, firm silty clay loam about 11 inches thick. The underlying material is black silty clay loam to a depth of 60 inches.

Minor in this association are Kennebec, Sharpsburg, and Zook soils. Nearly level, moderately well drained Kennebec soils are on the slightly higher parts of the bottom lands. Sharpsburg soils are on uplands. Nearly level to slightly concave, poorly drained Zook soils are on slightly lower parts of the bottom lands.

Farms in this association are mainly the cash grain type. Grain sorghum, corn, soybeans, and wheat are the main crops. Some of the grain is used on the farms as cattle and hog feed. Grain grown for cash sale is marketed mainly at local elevators. A few areas along drainageways are in trees and grass and are used for grazing or wildlife habitat.

Flooding and wetness are the main problems in this association. Maintaining content of organic matter, soil fertility, and soil structure are also concerns.

Most soils in this association have severe limitations for dwellings and sanitary facilities because of the flooding and wetness.

3. Haynie-Sarpy-Onawa Association

Deep, nearly level and very gently sloping, somewhat poorly drained to excessively drained, silty, clayey, and sandy soils that formed in alluvium; on bottom lands

This association is mainly on low, nearly level bottom lands of the Platte River and Missouri River valleys (fig. 3). Some areas are dissected by shallow swales and channels, and a few areas have gently undulating topography. The areas are subject to occasional flooding, and water ponds in the lowest areas.

This association occupies 15,150 acres, or about 4 percent, of the county. It is about 27 percent Haynie soils, 17 percent Sarpy soils, 14 percent Onawa soils, and 42 percent minor soils.

Haynie soils are deep, moderately well drained, and nearly level. The surface layer is very dark grayish brown, very friable, calcareous silt loam about 7 inches thick. The underlying material is stratified, calcareous silt loam and very fine sandy loam to a depth of 60 inches. It is mostly dark grayish brown with thin strata of very dark grayish brown and dark brown.

Sarpy soils are at the higher positions. These soils are deep and excessively drained. They are nearly level and very gently sloping, undulating soils. The surface layer is very dark grayish brown loamy fine sand about 6 inches thick. The underlying material, to a depth of 60 inches, is stratified very dark grayish brown and dark grayish brown fine sand, loamy fine sand, and very fine sandy loam.

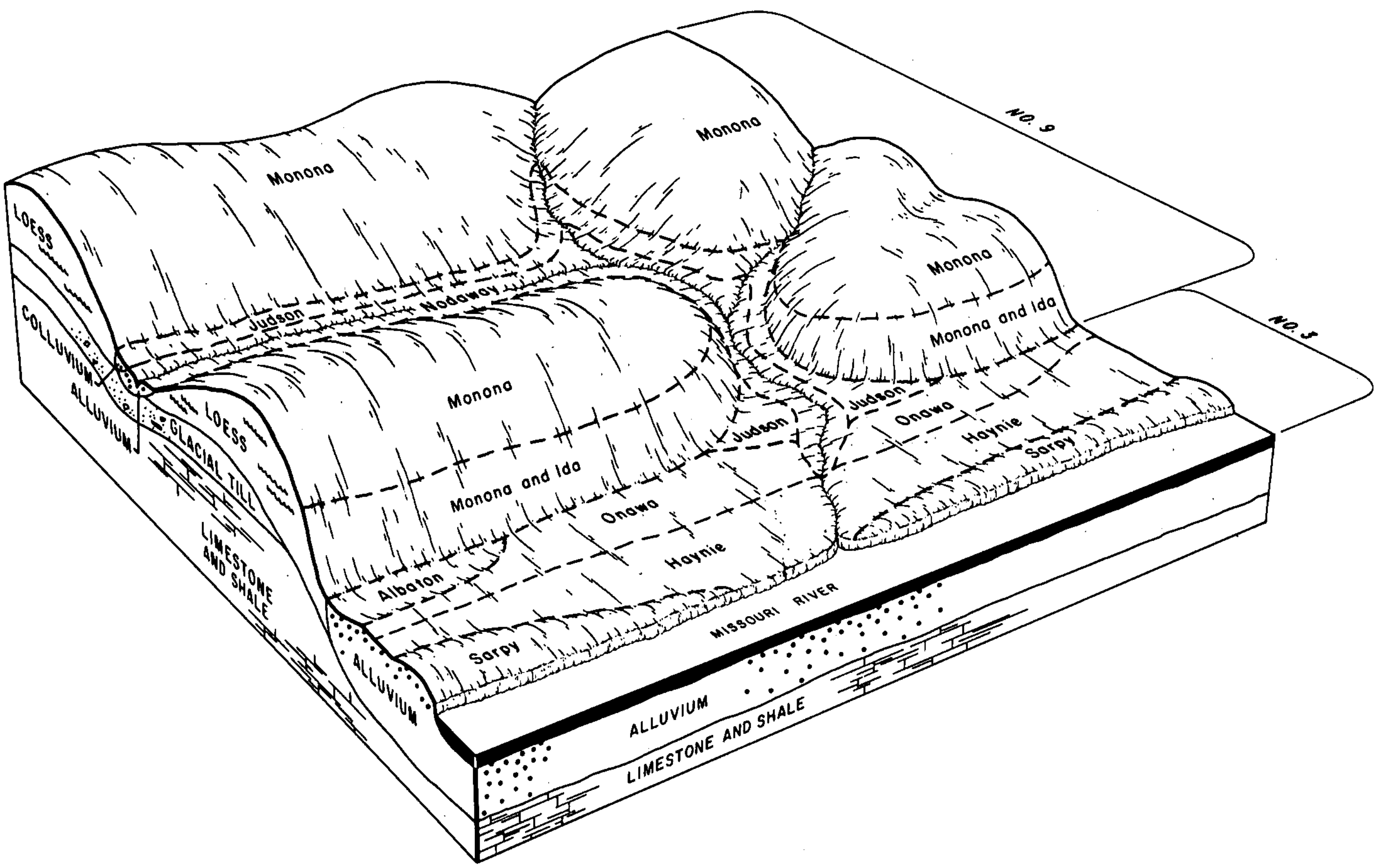

Figure 3.—Typical pattern of soils and underlying material in the Haynie-Sarpy-Onawa (No. 3) and Monona (No. 9) associations.

Onawa soils are at the somewhat lower positions. They are deep, somewhat poorly drained, and nearly level. The surface layer is very dark grayish brown, firm silty clay about 8 inches thick. The upper 19 inches of the underlying material is stratified very dark gray and very dark grayish brown clay and silty clay. The lower part of the underlying material, to a depth of 60 inches, is stratified dark grayish brown silty clay loam, silt loam, and very fine sandy loam.

Minor in this association are Albaton, Judson, Kennebec, and Nodaway soils. Albaton soils contain more clay and are on lower parts of the landscape. Judson and Kennebec soils have a thicker, darker surface layer and are on higher parts of the landscape. Nodaway soils are moderately well drained and are at the higher positions. Pits and dumps make up nearly 1,400 acres of this association.

Farms are mostly the cash grain type. Corn and soybeans are the main crops. Some areas are irrigated; ground water of good quality is generally abundant. Some of the grain is used on farms as cattle and hog feed. Grain for cash sale is marketed mainly at local elevators. In areas not protected by dikes, there are small tracts of trees.

Flooding is a hazard unless the soils are protected by dikes. Another concern in management is wetness in swales and during periods when the water table is high.

Soils in this association are severely limited for dwellings and sanitary facilities because of the flooding and wetness.

Moderately well drained, well drained, and poorly drained, silty soils on uplands and terraces

These deep, silty soils are dominantly gently sloping and strongly sloping but range from nearly level to moderately steep.

These soils make up about 67 percent of the county. Most of the acreage is cropped to corn, soybeans, wheat, and grain sorghum. Erosion by water in gently sloping and strongly sloping areas and ponding in depressions are the main problems. Conserving moisture for use by plants and maintaining fertility are the main concerns in management.

4. Sharpsburg Association

Deep, nearly level to moderately steep, moderately well drained, silty soils that formed in loess; on uplands

This association is made up of soils on alternating divides and side slopes of uplands. It includes a few soils on foot slopes, bottom lands, and stream terraces adjacent to steep side slopes (fig. 4). Soils on the divides are nearly level to gently sloping. Soils on the side slopes are gently sloping to moderately steep. Slope ranges from 0 to 15 percent.

This association occupies 148,500 acres, or about 42 percent, of the county. It is about 83 percent Sharpsburg soils and 17 percent minor soils.

Sharpsburg soils are on uplands. They are deep, moderately well drained, and nearly level to moderately steep. The surface layer is very dark brown, friable silty clay loam about 6 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 8 inches thick. The subsoil is about 31 inches thick. The upper part of the subsoil is dark brown, friable silty clay loam and silty clay; the middle part is dark yellowish brown, friable silty clay loam; and the lower part is yellowish brown, friable silty clay loam. The underlying material is yellowish brown and grayish brown silty clay loam to a depth of 60 inches. In some places the surface layer is thinner and lighter colored.

Minor in this association are Colo, Judson, Nodaway, and Wymore soils. Colo soils are poorly drained and are on bottom lands. Judson soils have a thicker, darker surface layer and are on foot slopes. Nodaway soils are nearly level and are on the bottom of upland drainageways. Wymore soils are on uplands and contain more clay in the profile.

Farms are mainly the cash grain type with a few livestock enterprises. Several farmsteads are located on the high ridges. In most places, the supply of ground water is limited, but it generally is adequate for domestic use. Some farms have water supplied through pipelines by rural water districts. Nearly all of this association is used for cultivated crops. Corn, soybeans, grain sorghum, and wheat are the main crops. Some alfalfa and clover are also grown. Some small tracts are planted to introduced grasses. Most of the cash grain is marketed in local communities before it is shipped to larger terminals. Fattened cattle and hogs are marketed at Omaha stockyards or local auctions or are sold directly to packers.

Water erosion is the main problem in this association. Maintaining organic matter content and soil structure and selecting crops that are most suitable for the soils are also concerns in management. Some farms have a complete conservation management system including terraces, contour farming, grassed waterways, and conservation tillage.

Soils in this association are generally moderately to severely limited for septic tank absorption fields because of the moderately slow permeability and slope. The soils are limited for dwellings, roads, and streets because of the high shrink-swell potential and high frost action potential.

5. Sharpsburg-Fillmore Association

Deep, nearly level to strongly sloping, moderately well drained and poorly drained, silty soils that formed in loess; on terraces

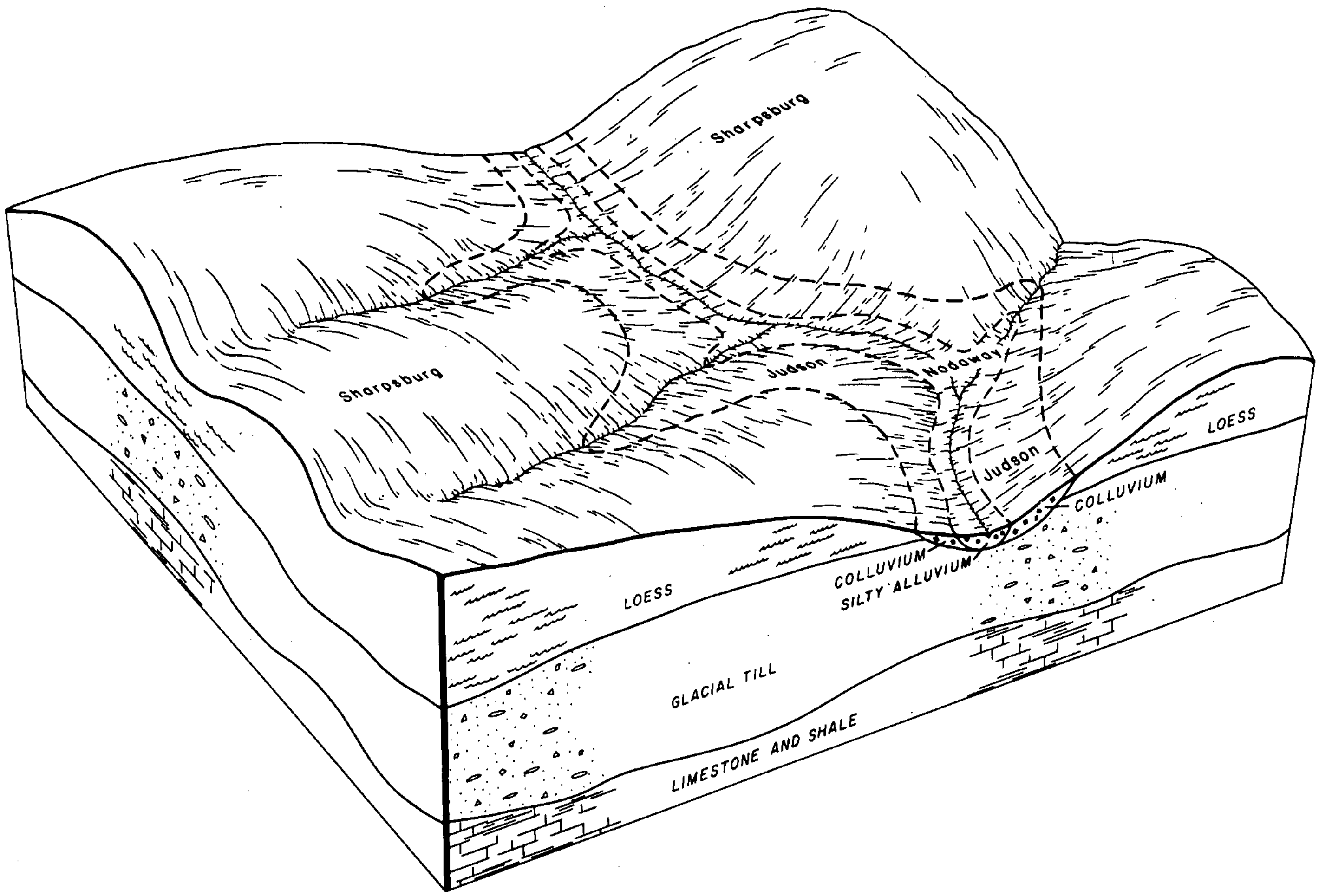

Figure 4.—Typical pattern of soils and underlying material in the Sharpsburg association.

This association consists of soils on stream terraces along Salt Creek (fig. 2).

This association occupies 5,225 acres, or about 2 percent, of the county. It is about 73 percent Sharpsburg soils, 11 percent Fillmore soils, and 16 percent minor soils.

Sharpsburg soils are on the upper parts of the landscape. They are nearly level to strongly sloping and moderately well drained. The surface layer is very dark brown, friable silty clay loam about 7 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 10 inches thick. The subsoil is friable silty clay loam about 35 inches thick; the upper part is dark brown, the middle part is dark yellowish brown, and the lower part is yellowish brown. The underlying material is yellowish brown silty clay loam to a depth of 60 inches.

Fillmore soils are in shallow depressions on stream terraces. They are poorly drained. The surface layer is very dark gray, friable silt loam about 9 inches thick. The subsurface layer is dark gray, very friable silt loam about 10 inches thick. The subsoil is about 29 inches thick; it is very dark grayish brown, very firm silty clay in the upper part and dark grayish brown, very firm silty clay in the lower part. The underlying material is dark grayish brown silty clay to a depth of 60 inches.

Minor in this association are Colo, Judson, Kennebec, and Nodaway soils. Colo soils are poorly drained and occasionally flooded. Judson soils are on colluvial foot slopes. Kennebec soils are moderately well drained and are on bottom lands. Nodaway soils are in areas dissected by deeply entrenched meandering streams and are occasionally or frequently flooded.

Farms are mostly the cash grain type. Grain sorghum, corn, and wheat are the main crops. Some alfalfa is also grown. Grain grown for cash sale is marketed mainly at local elevators.

Controlling erosion, maintaining the content of organic matter, and keeping fertility high are the main concerns in management in this association. Ponding in the depressions is the main problem on the Fillmore soils.

Conservation tillage practices that leave crop residue on the surface conserve moisture and reduce erosion.

Soils in this association are moderately to severely limited for septic tank absorption fields because of moderately slow to slow permeability. Some areas are severely limited because of wetness and ponding in the depressions. These soils are severely limited for dwelling sites because of high shrink-swell potential and wetness in the depressions.

6. Marshall Association

Deep, gently sloping to moderately steep, well drained, silty soils that formed in loess; on uplands

This association is mainly on uplands that have narrow divides and side slopes. The ridgetops are gently sloping, and the side slopes are moderately steep. Narrow valleys of both perennial and intermittent streams drain this dissected landscape.

This association occupies 82,480 acres, or about 23 percent, of the county. It is about 80 percent Marshall soils and 20 percent minor soils.

Marshall soils are gently sloping on the ridgetops and strongly sloping to moderately steep on the side slopes and near the upper end of the drainageways. The surface layer is very dark brown, friable silty clay loam about 6 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 8 inches thick. The subsoil is friable silty clay loam about 31 inches thick; the upper part is dark brown, and the lower part is dark yellowish brown. The underlying material is yellowish brown silty clay loam to a depth of 60 inches.

Minor in this association are Colo, Nodaway, Judson, Monona, and Sharpsburg soils. Colo and Nodaway soils are on bottom lands. Colo soils are somewhat poorly drained. Nodaway soils are moderately well drained but are subject to flooding. Judson soils are on foot slopes and on side slopes of narrow drainageways. Monona soils have less clay in the profile. Sharpsburg soils have more clay in the subsoil.

Farms are mainly the cash grain type with a few livestock enterprises. In most places, the supply of ground water is limited, but it generally is adequate for domestic use. Some farms have water supplied through pipelines by rural water districts. Nearly all of this association is used for cultivated crops. Some small tracts are planted to introduced grasses. Corn, soybeans, grain sorghum, and wheat are the main crops. Some alfalfa and clover are grown. Most of the cash grain is marketed at local elevators. Fattened cattle and hogs are marketed at Omaha stockyards or local auctions or are sold directly to packers.

Water erosion is the main problem in this association. Maintaining organic matter content and soil structure and selecting crops that are most suitable for the soils are also concerns in management. Some farms have a complete conservation management system including terraces, contour farming, grassed waterways, and conservation tillage.

Strongly sloping to moderately steep soils in this association are moderately limited for septic tank absorption fields. These soils are moderately limited for dwelling sites and roads because of the moderate shrink-swell potential.

Moderately well drained, silty soils on uplands

These deep soils are dominantly nearly level to strongly sloping. They are silty soils with a clayey subsoil. These soils are on uplands.

These soils make up more than 10 percent of the county. Most of the acreage is cropped to wheat and grain sorghum. Water erosion in gently sloping and strongly sloping areas is the main problem. Conserving moisture for use by plants and maintaining fertility are the main concerns in management.

7. Wymore Association

Deep, nearly level to strongly sloping, moderately well drained, silty soils that formed in loess; on uplands

This association consists of divides and side slopes along upland drainageways (fig. 5). The divides are nearly level to gently sloping, and the side slopes are gently sloping to strongly sloping.

This association occupies 36,470 acres, or about 10 percent, of the county. It is about 82 percent Wymore soils and 18 percent minor soils.

Wymore soils are on both divides and side slopes. The surface layer is very dark brown, friable silty clay loam about 9 inches thick. The subsoil is about 39 inches thick. The upper part of the subsoil is very dark grayish brown, firm silty clay loam; the middle part is dark grayish brown, firm silty clay; and the lower part is grayish brown, firm silty clay. The underlying material is grayish brown silty clay loam to a depth of 60 inches.

Minor in this association are Colo, Judson, Mayberry, Nodaway, Pawnee, and Sharpsburg soils. Colo soils are on bottom lands, are poorly drained, and are occasionally flooded. Judson soils are nearly level to gently sloping and are on colluvial foot slopes. Mayberry and Pawnee soils are on side slopes and formed in glacial deposits. Nodaway soils are on bottom lands and are frequently flooded. Sharpsburg soils are on divides and side slopes and have less clay in the subsoil.

Farms in this association are mainly the cash grain type. Grain sorghum and wheat are the principal crops. Soybeans and alfalfa are also grown. Most of the crops are dryfarmed because ground water supplies are generally inadequate for irrigation. Some of the grain is used on the farm as cattle and hog feed. Grain grown for cash is marketed mainly at local elevators.

Water erosion is the main problem on the sloping cultivated soils in this association. Low moisture supply to plants is a limitation during periods of drought.

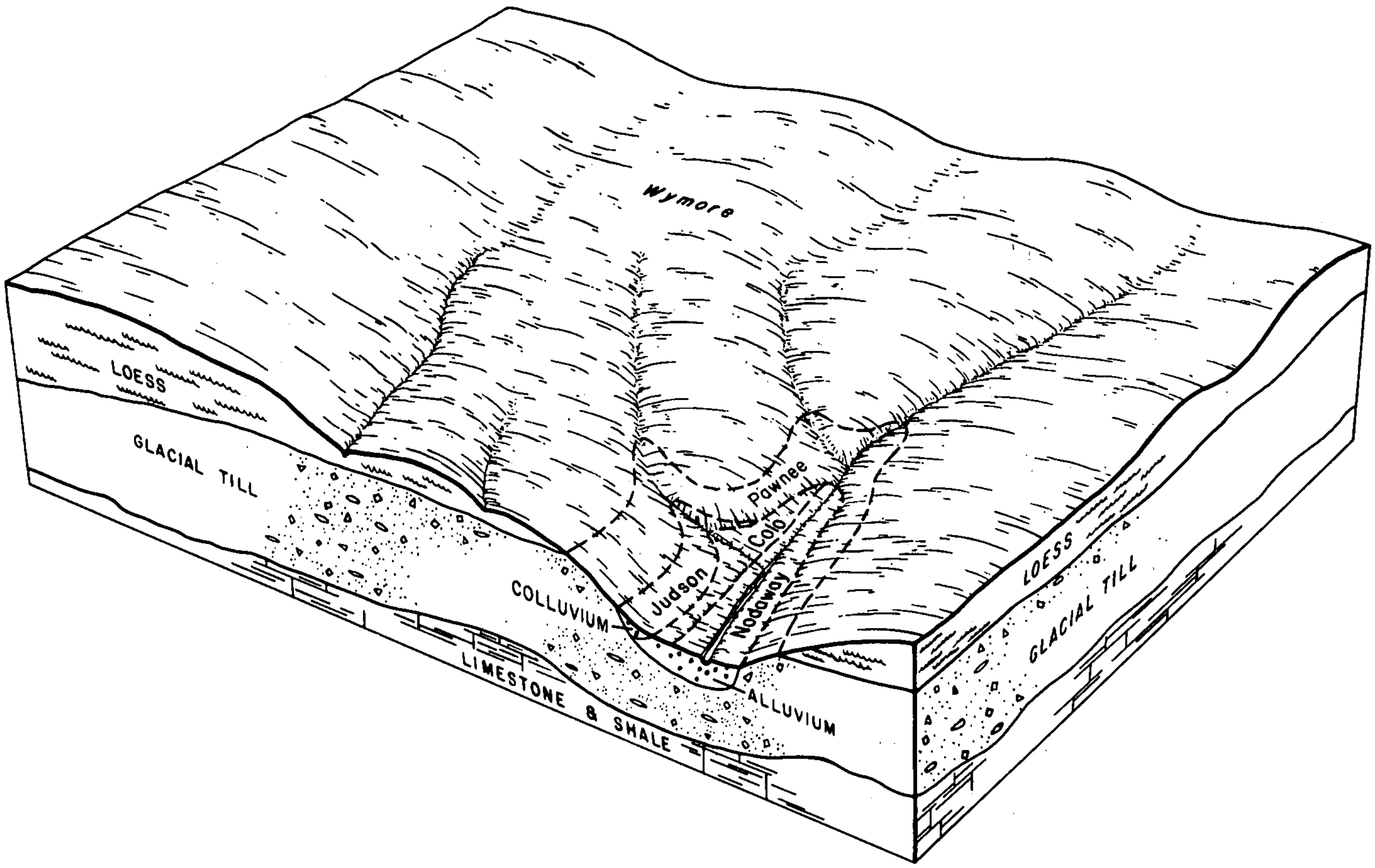

Figure 5.—Typical pattern of soils and underlying material in the Wymore association.

Conserving moisture is a concern if these soils are cultivated.

The soils in this association are severely limited for septic tank absorption fields because of slow permeability and slope. These soils are severely limited for dwelling sites and roads because of wetness and high shrink-swell potential.

Moderately well drained, silty and loamy soils on uplands and bottom lands

These deep, silty and loamy soils are dominantly nearly level to strongly sloping. They are on bottom lands and side slopes of uplands.

These soils make up about 1 percent of the county. Most of the acreage is cropped to wheat, corn, and grain sorghum. Some areas are pastures used for grazing. Water erosion in gently sloping and strongly sloping areas and flooding on the bottom lands are the main problems. Conserving moisture for use by plants and maintaining fertility are the main concerns in management.

8. Mayberry-Nodaway-Pawnee Association

Deep, nearly level to strongly sloping, moderately well drained, silty and loamy soils that formed in glacial deposits and alluvium; on uplands and bottom lands

This association consists of strongly sloping side slopes, nose slopes, and bottom lands along the more entrenched upland drainageways.

This association occupies 4,960 acres, or about 1 percent, of the county. It is about 29 percent Mayberry soils, 20 percent Nodaway soils, 13 percent Pawnee soils, and 38 percent minor soils.

Mayberry soils are on strongly sloping ridgetops and side slopes. Erosion has removed much of the original dark surface layer over most of the area. Typically, the surface layer is dark brown, friable silty clay loam about 6 inches thick. The subsoil is about 44 inches thick; the upper part is dark brown, firm silty clay, and the lower part is dark brown, firm clay. The underlying material is yellowish brown clay loam to a depth of 60 inches.

Nodaway soils are on nearly level bottom lands commonly adjacent to intermittent drainageways. They are moderately well drained. The surface layer is very dark grayish brown, friable silt loam about 7 inches thick. The underlying material is stratified very dark grayish brown and dark grayish brown silt loam to a depth of 60 inches.

Pawnee soils are on strongly sloping ridgetops and side slopes generally in the higher parts of the landscape. Erosion has removed much of the original dark surface layer over most of the area. Typically, the surface layer is very dark grayish brown, friable clay loam about 6 inches thick. The subsoil is firm clay about 36 inches thick; the upper part is brown, the middle part is olive brown, and the lower part is light olive brown. The underlying material is light olive brown and is clay in the upper part and clay loam in the lower part to a depth of 60 inches. Mottles are present in the lower part of the subsoil and below.

Minor in this association are mainly Colo, Judson, and Wymore soils. Colo soils are poorly drained, nearly level, and occasionally flooded. Judson soils are nearly level to gently sloping and are on colluvial foot slopes. Wymore soils are on divides and side slopes, formed in loess, and have less coarse material than Mayberry or Pawnee soils.

Farms in this association are mainly the cash grain type with a few livestock enterprises. The broader, nearly level bottom lands and gently sloping side slopes are used mainly for cultivated crops. The strongly sloping side slopes and narrow bottom lands support grass and trees and are used for grazing and wildlife habitat. Wheat, grain sorghum, and legumes are the main crops.

Erosion by water is the main problem in this association. Maintaining soil fertility is a concern in management. The major soils in this association may need lime if alfalfa is grown.

Soils in this association are severely limited for septic tank absorption fields because of slow permeability and slope. The Mayberry and Pawnee soils are severely limited for dwelling sites and roads because of wetness and high shrink-swell potential, and Nodaway soils are severely limited because of flooding.

Well drained, silty soils on uplands

These deep, silty soils are dominantly strongly sloping to steep but range from gently sloping to very steep. They are on uplands.

These soils make up about 9 percent of the county. Over half of the acreage is cropped to corn, soybeans, and wheat. The balance is in grass and trees and is used for grazing or habitat for wildlife. Erosion by water is the main problem. Maintaining a high level of fertility, controlling runoff, and conserving moisture for plants are the main concerns in management.

9. Monona Association

Deep, gently sloping to very steep, well drained, silty soils that formed in loess; on uplands

This association consists mainly of ridges, hillsides, and narrow valleys on uplands bordering the two major river systems (fig. 3). The rounded ridges are gently sloping. The side slopes vary in length and slope: most are long and smooth but some are abrupt and very steep.

This association occupies 31,280 acres, or about 9 percent, of the county. It is about 75 percent Monona soils and 25 percent minor soils.

Monona soils are gently sloping on the ridgetops and steep on the side slopes and near the upper end of drainageways. The surface layer is very dark grayish brown, friable silt loam about 6 inches thick. The subsurface layer also is very dark grayish brown, friable silt loam about 6 inches thick. The subsoil is friable silt loam about 23 inches thick; it is dark brown and very dark grayish brown in the upper part and dark yellowish brown in the lower part. The underlying material is yellowish brown silt loam to a depth of 60 inches.

Minor in this association are Colo, Ida, Judson, Marshall, and Nodaway soils. Colo and Nodaway soils are on bottom lands of narrow drainageways. Colo soils are somewhat poorly drained. Nodaway soils are moderately well drained and stratified. Ida soils have a thinner surface layer, contain carbonates at shallower depths, and are steeper than Monona soils. Judson soils are on foot slopes or on side slopes of narrow drainageways and have a thicker, darker surface layer. Marshall soils have more clay in the subsoil.

Farms in this association are diversified, being mainly a combination of cash grain and livestock enterprises. Farmsteads occur throughout the association and are usually on the ridgetops. Well water is limited, but it is usually sufficient for households. Most of the gently sloping and strongly sloping areas are cultivated. Most of the steeper areas are in grass or trees, but some are cultivated. The steepest areas are in grass and trees and serve as habitat for wildlife. The main crops are corn, soybeans, wheat, and alfalfa. Most of the cash grain is marketed in local communities before it is shipped to larger terminals. Fattened cattle and hogs are marketed at Omaha stockyards or local auctions or are sold directly to packers.

Water erosion is the main problem in this association. Maintaining organic matter content and fertility are concerns in management when the soils are cultivated. Areas used for pasture require proper stocking rates and rotation grazing to maintain or improve the stand and vigor of the grasses.

Strongly sloping and moderately steep soils in this association are moderately limited for septic tank absorption fields. The soils in this association are moderately limited for dwelling sites because of the shrink-swell potential, and the steep soils are severely limited because of slope. These soils are also severely limited for roads because of low strength and frost action.

Moderately well drained and somewhat excessively drained, silty soils on uplands

These silty soils are dominantly strongly sloping to steep. In some areas they are gently sloping. They are deep or are shallow and very shallow to rock. These soils are on uplands.

These soils make up about 2 percent of the county. Most of the acreage is in trees and grass. The main uses of this area are mining of limestone, wildlife habitat, and livestock grazing. Erosion by water in gently sloping and strongly sloping areas and shallow depth to bedrock are the main problems. Conserving moisture for use by plants and maintaining fertility are the main concerns in management.

10. Sharpsburg-Sogn Association

Deep and shallow, gently sloping to steep, moderately well drained and somewhat excessively drained, silty soils that formed in loess and material weathered from limestone; on uplands

This association consists mainly of valleys and side slopes along upland drainageways. The side slopes are moderately steep to steep, and the soils are shallow or very shallow to limestone rock. In places, limestone crops out of vertical escarpments. There are many abandoned quarries where building stone was removed in pioneer days.

This association occupies 7,719 acres, or about 2 percent, of the county. It is about 32 percent Sharpsburg soils, 19 percent Sogn soils, and 49 percent minor soils and miscellaneous areas.

Sharpsburg soils are on side slopes next to drainageways. They are deep and moderately well drained and are gently sloping to moderately steep. Erosion has removed much of the original dark surface soil over most of the area. The surface layer is dark brown, friable silty clay loam about 6 inches thick. The subsoil is friable silty clay loam about 24 inches thick; it is dark yellowish brown in the upper part and yellowish brown in the lower part. The underlying material is yellowish brown silty clay loam to a depth of 60 inches.

Sogn soils are on side slopes next to drainageways. They are shallow, somewhat excessively drained, and moderately steep to steep. The surface layer is black, friable silty clay loam about 5 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 5 inches thick. Below this is limestone bedrock.

Minor in this association are Geary, Judson, and Nodaway soils, which are all deep. Geary soils are browner and are closely intermingled with the major soils. Judson soils are on foot slopes below the Sogn soils. Nodaway soils are on gently sloping bottom lands in narrow valleys of the upland drainageways. Several limestone quarries occupy large areas in this association.

Nearly all of the farms in this association are the grain-livestock type. The moderately steep and steep areas are in trees and native grass. These areas are used mainly for wildlife habitat and range and as a source of limestone rock. The gently sloping and strongly sloping areas generally are cultivated. Grain sorghum, corn, soybeans, and wheat are the principal crops. Some alfalfa is also grown. Fattened cattle and hogs are marketed at Omaha stockyards or local auctions or are sold directly to packers.

Erosion is the main problem in this association. Conserving moisture, organic matter, and fertility in the cropped areas and maintaining a desirable permanent plant cover in the steep areas and areas of shallow soils are concerns in management.

The Sharpsburg soils in this association are moderately limited for septic tank absorption fields because of moderately slow permeability. The Sogn soils are severely limited for septic tank absorption fields because of shallow depth to bedrock.

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, Sharpsburg silty clay loam, 2 to 5 percent slopes, is one of several phases in the Sharpsburg 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. Colo-Nodaway complex, 0 to 2 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 and dumps 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.

Ab—Albaton silty clay, 0 to 1 percent slopes. This deep, nearly level, poorly drained soil is on the Platte River and Missouri River bottom lands. The soil formed in clayey alluvium. This soil is occasionally flooded. Areas are long and narrow and range from 10 acres to over 100 acres.

Typically, the surface layer is very dark grayish brown, firm silty clay about 6 inches thick. The underlying material is stratified very dark grayish brown, dark grayish brown, and grayish brown, mottled silty clay and clay to a depth of 60 inches. The profile is calcareous throughout.

Included with this soil in mapping are small areas of Onawa soils and soils that have an overwash of coarser textured material. Onawa soils are less clayey in the lower part of the profile and are somewhat poorly drained. Included soils are at slightly higher positions and make up about 10 percent of the map unit.

Permeability is very slow, and available water capacity is moderate. Runoff is slow. The seasonal high water table rises to a depth of about 1 to 3 feet, but it is lower during the growing season. This soil dries slowly and stays wet later in spring. Tilth is poor. Organic matter content is moderate, and natural fertility is high. The shrink-swell potential is high.

Most areas of this soil are used for farming. Some areas are irrigated. A few areas are in grass and trees.

This soil is suited to corn, soybeans, and sorghum. Row crops can be grown several years in succession. Wetness early in spring when rainfall is heaviest is the main limitation. The soil is flooded occasionally, but damage to crops is seldom severe. Surface water stands in low areas for several days after a rain or overflow.

Proper placement of rows, land leveling, and surface ditching improve drainage. If there are suitable outlets, drainage tile can be used to lower the seasonal high water table. Returning crop residue to the soil helps to maintain organic matter content and soil structure. Applying fertilizer helps to maintain fertility.

Under irrigation, this soil is suited to corn, grain sorghum, and soybeans. Soil wetness in spring and early summer is the main problem. Land leveling can improve surface drainage and increase irrigation efficiency. Gravity and sprinkler irrigation systems are suitable.

This soil is suited to pasture or hay if grasses that tolerate wet conditions are used. Pastures commonly consist of smooth brome, reed canarygrass, prairie cordgrass, and tall fescue. The grasses should be harvested before they become coarse and unpalatable. Overgrazing or grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking, rotation grazing, and applying nitrogen fertilizer help to keep the grass in good condition.

This soil is suited to trees and shrubs in windbreaks. Survival and growth of species that tolerate occasional wetness are good. Weeds and grasses can be controlled by cultivating between the rows with conventional equipment and by applying appropriate herbicides in the tree rows. Areas near the trees can be hoed by hand or rototilled. Establishing seedlings can be a problem during wet periods. A light cultivation and supplemental watering can be used to close the cracks that form during dry periods.

This soil is generally unsuitable for building sites and septic tank absorption fields because of flooding, wetness, and very slow permeability. Other sites should be found for these uses. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. 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 and wetness. Mixing the base material with hydrated lime increases strength and helps to prevent excessive shrinking and swelling.

This soil is in capability units IIIw-1 dryland and IIIw-1 irrigated, Clayey Overflow range site, and windbreak suitability group 2W.

BmD—Burchard-Morrill clay loams, 6 to 11 percent slopes. These deep, strongly sloping, well drained soils are on side slopes along drainageways on uplands. These soils formed in calcareous glacial till and outwash. Individual areas range from 3 to 20 acres in size. This complex is 35 to 55 percent Burchard soil and 30 to 50 percent Morrill soil. Areas of the two soils are so small in size or so intricately mixed that it was not practical to separate them in mapping.

Typically, the Burchard soil has a surface layer of very dark grayish brown, friable clay loam about 7 inches thick. The subsoil is about 37 inches thick. The upper part of the subsoil is dark brown, friable clay loam; the middle part is light olive brown, firm, calcareous clay loam; and the lower part is light yellowish brown, firm, calcareous clay loam. The underlying material is light brownish gray and light yellowish brown, calcareous clay loam to a depth of 60 inches.

Typically, the Morrill soil has a surface layer of very dark grayish brown, friable clay loam about 7 inches thick. The subsoil is about 40 inches thick. The upper part of the subsoil is dark brown, friable clay loam, and the lower part is dark brown, friable sandy clay loam. The underlying material is yellowish brown sandy loam in the upper part and light olive brown clay loam in the lower part to a depth of 60 inches. In places, the subsoil is not as red.

Included with these soils in mapping are small areas of Judson, Mayberry, Pawnee, and Wymore soils. Judson soils are on foot slopes and have a thicker surface soil. The Mayberry, Pawnee, and Wymore soils are on the upper parts of the side slopes and contain more clay in the subsoil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow in the Burchard and Morrill soils. Available water capacity is high. Moisture is released readily to plants. Runoff is rapid. Organic matter content is moderate, and natural fertility is medium. Roots can be restricted by the compact clay loam subsoil. The shrink-swell potential is moderate in the subsoil.

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

These soils are poorly suited to corn, grain sorghum, soybeans, wheat, and alfalfa. If cultivated, these soils are best suited to close-growing crops. Limiting row crops helps to control erosion and conserve water. Terraces slow runoff and reduce erosion. Returning crop residue to the soil helps to maintain and improve organic matter content. Contour farming and grassed waterways help to control erosion.

These soils are suited to grasses, which help to control erosion. Introduced grasses, such as smooth brome, need fertilizer. Proper stocking, timely mowing, rotation grazing, and fertilizing help to keep the grass and soil in good condition.

These soils are suitable for trees and shrubs in windbreaks. Weeds and grasses can be controlled by cultivating between the rows with conventional equipment. Appropriate herbicides can be applied in the row, or areas can be hoed by hand or rototilled. Trees should be planted on the contour to reduce the hazard of erosion.

The moderately slow permeability of these soils is a limitation for septic tank absorption fields but can generally be overcome by increasing the size of the absorption fields. For proper operation of the septic tank absorption field, the land should be reshaped and lines laid on the contour. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling. Dwellings need to be designed to fit the slope, or the soils can be graded to an acceptable slope. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance.

These soils are in capability unit IVe-1 dryland, Silty range site, and windbreak suitability group 3.

Co—Colo silty clay loam, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on occasionally flooded bottom lands. The soil formed in alluvium. Individual areas of this unit are irregular in shape and range from 5 to 300 acres in size.

Typically, the surface layer is very dark gray, friable silty clay loam about 7 inches thick. The subsurface layer is friable silty clay loam about 19 inches thick; the upper part is black, and the lower part is very dark gray. The subsoil is very dark gray, mottled, firm silty clay loam about 11 inches thick. The underlying material is black silty clay loam to a depth of 60 inches. In some places, the original soil is covered with less than 20 inches of stratified silt loam.

Included with this soil in mapping are small areas of Judson, Kennebec, and Zook soils. Kennebec and Judson soils are at the higher, better drained positions. Zook soils contain more clay. Included areas make up about 15 percent of the map unit.

Permeability is moderately slow. Available water capacity is high, and moisture is released readily to plants. Runoff is slow. The seasonal high water table rises to a depth of about 2 feet in most wet years and 3 feet in most dry years. Natural fertility and organic matter content are high. Tilth is fair. The shrink-swell potential is high.

Nearly all of the acreage of this soil is cultivated.

This soil is suited to corn, grain sorghum, alfalfa, and soybeans. Row crops can be grown several years in succession. Excess wetness caused by the seasonal high water table delays tillage and planting. If suitable outlets are available, tile drains can be used to lower the water table and control wetness. In dry years, the high water table is beneficial to crops. Terraces, diversion ditches, and grassed waterways on adjacent, higher lying soils reduce runoff onto this soil and lessen flood damage.

This soil is suited to irrigation. Corn, grain sorghum, alfalfa, and soybeans can be grown in irrigated areas. The chief limitation is excessive wetness, which delays tillage and planting in spring.

This soil is suited to pasture. Pastures commonly consist of reed canarygrass or smooth brome. Overgrazing and grazing when the soil is too wet cause surface compaction and poor tilth. Proper stocking and rotation grazing help to keep the grass in good condition.

This soil is suited to windbreaks if trees and shrubs that can tolerate occasional wetness are used. Establishment of plantings is sometimes difficult during wet years. Weeds and grasses can be controlled by cultivation with conventional equipment between the rows. Areas near the trees can be hoed by hand or rototilled.

This soil is generally unsuitable for dwelling sites and septic tank absorption fields because of flooding and wetness. Other sites should be found. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. Constructing roads on suitable, well compacted fill material above flood level and providing adequate side ditches and culverts help to protect the roads from flood damage. Damage to roads 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 soil is in capability units IIw-4 dryland and IIw-3 irrigated, Clayey Overflow range site, and windbreak suitability group 2S.

Cp—Colo-Nodaway complex, 0 to 2 percent slopes. These deep, nearly level, poorly drained and moderately well drained soils are on bottom lands along drainageways in the uplands. These soils formed in alluvium. Flooding is frequent. Channels that cross these soils are generally less than 5 feet deep. Areas are long and narrow and range from 5 to 100 acres in size. This complex is 40 to 60 percent Colo soil and 30 to 50 percent Nodaway soil. Commonly, the poorly drained Colo soil is in lower areas away from the stream channel, and the moderately well drained Nodaway soil is at slightly higher positions next to the channel. Areas of these soils are so intricately mixed that it was not practical to separate them in mapping.

Typically, the Colo soil has a surface layer of very dark grayish brown, friable silty clay loam about 5 inches thick. The subsurface layer is very dark gray, friable silty clay loam about 19 inches thick. The underlying material is black, mottled silty clay loam to a depth of 60 inches.

Typically, the Nodaway soil has a surface layer of very dark grayish brown, friable silty clay loam about 8 inches thick. The underlying material is stratified very dark grayish brown silty clay loam in the upper part and black silty clay loam in the lower part to a depth of 60 inches.

Included with these soils in mapping are small areas of Judson and Kennebec soils. The moderately well drained Judson and Kennebec soils are at higher positions. Included areas make up 5 to 15 percent of the map unit.

Permeability is moderately slow in the Colo soil and moderate in the Nodaway soil. Available water capacity is high in both soils. Runoff is slow. The seasonal high water table rises to a depth of 1 to 3 feet in the Colo soil and 3 to 5 feet in the Nodaway soil. These soils dry slowly, especially during prolonged wet spring seasons. Tilth is poor in the Colo soil and fair in the Nodaway soil. Organic matter content is high in the Colo soil and moderate in the Nodaway soil. Natural fertility is high in both soils.

Most of the acreage of this complex is in grass and trees and is used mainly for grazing. A few areas are cultivated.

These soils are poorly suited to corn, grain sorghum, and soybeans. Small grain and alfalfa are likely to be damaged by flooding. Terracing and conservation tillage on adjoining uplands and flood control structures reduce the hazard of flooding and silting from eroding upland soils. Wetness in spring often delays tillage. If outlets are available, tile drains lower the water table. Returning crop residue to the soil helps to maintain organic matter content.

These soils are poorly suited to irrigation, but corn, grain sorghum, and soybeans can be grown in irrigated areas. Wetness in spring delays tillage and planting.

These soils are suited to grasses and are used for pasture or hay. Pastures consist mainly of smooth brome, orchardgrass, and reed canarygrass. Weeds and woody plants can be controlled by chemicals. Proper stocking, timely mowing, rotation grazing, and fertilizing help to keep the grass in good condition.

These soils are suited to windbreaks if trees and shrubs that tolerate occasional wetness are used. Few trees are planted because cottonwood and willow commonly grow on these soils. Weeds and grasses can be controlled by cultivating between the rows with conventional equipment. Areas near the trees can be hoed by hand or rototilled.

These soils are generally unsuitable for dwelling sites and septic tank absorption fields because of flooding and wetness. Other sites should be found. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. Constructing roads on suitable, well compacted fill material above flood level and providing adequate side ditches and culverts help to protect the roads from flood damage and wetness. Damage to roads 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.

These soils are in capability units IIIw-4 dryland and IVw-3 irrigated. The Colo soil is in Subirrigated range site and windbreak suitability group 2W. The Nodaway soil is in Silty Overflow range site and windbreak suitability group 1.

Fm—Fillmore silt loam, 0 to 1 percent slopes. This deep, nearly level, poorly drained soil is in depressions or basins on uplands and stream terraces. The soil formed in loess. It is generally ponded after spring thaw and heavy rains (fig. 6). Individual areas range from 3 acres to over 40 acres in size.

Typically, the surface layer is very dark gray, friable silt loam about 9 inches thick. The subsurface layer is dark gray, very friable silt loam about 10 inches thick. The subsoil is about 29 inches thick; it is very dark gray and very dark grayish brown, very firm silty clay in the upper part and dark grayish brown, very firm silty clay in the lower part. The underlying material, to a depth of 60 inches, is dark grayish brown silty clay that has yellowish brown mottles.

Included with this soil in mapping are small areas of moderately well drained Sharpsburg or Wymore soils at the higher positions. These soils make up about 10 percent of the unit.

Permeability is very slow. The subsoil absorbs water slowly and releases the water to plants slowly. Runoff is very slow, and water ponds on this soil following heavy rains and snowmelt. A perched seasonal high water table is near or above the surface. Organic matter content is moderate, and natural fertility is medium. Tilth is fair. The subsoil is difficult for roots to penetrate. The shrink-swell potential of the subsoil is high.

Most of the acreage of this soil is cultivated along with the adjacent better drained soils. A few areas are in grass and are used for grazing and haying.

This soil is suited to grain sorghum, soybeans, and wheat. Planting and cultivation generally are delayed because of ponded water, and crops can be damaged. If outlets are available, the excess water can be removed by open ditches. Surface drainage is needed if the soil is to be successfully irrigated. Weed competition makes timely cultivation difficult. Returning crop residue to the soil helps to maintain organic matter content.

This soil generally is suited to irrigation. Corn, grain sorghum, and soybeans can be grown in irrigated areas. The chief limitation is excessive wetness. Land grading allows efficient water use and improves surface drainage.

This soil is suited to grasses. Pastures commonly consist of smooth brome, tall fescue, and reed canarygrass. Alfalfa stands are often destroyed by ponded water. Grazing when the soil is wet causes surface compaction. Proper stocking, timely mowing, and rotation grazing help to keep the grass in good condition.

This soil is suited to trees and shrubs for windbreaks. Survival and growth of species that tolerate occasional wetness is good. Weeds and grasses can be controlled by cultivation with conventional equipment between the

Figure 6.—Fillmore silt loam, 0 to 1 percent slopes, is usually wet or ponded in spring and after heavy rains.

rows. Areas near the trees can be hoed by hand or rototilled.

This soil is generally not suitable for septic tank absorption fields and dwelling sites because of ponding and very slow permeability. Other sites should be found. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. 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 by wetness from the seasonal high water table. Damage to roads by frost action can be reduced by providing good surface drainage and by using a gravel moisture barrier in the subgrade. Crowning the road helps to provide the needed surface drainage.

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

GeD2—Geary silty clay loam, 6 to 11 percent slopes, eroded. This deep, strongly sloping, well drained soil is on upland side slopes. The soil formed in silty material. Individual areas are irregular in shape and range from 3 to 35 acres in size. Erosion has removed much of the original dark surface layer over most of the area.

Typically, the surface layer is dark brown, friable silty clay loam about 7 inches thick. The subsoil is dark brown, friable silty clay loam about 39 inches thick. The underlying material is dark brown silty clay loam to a depth of 60 inches.

Included with this soil in mapping are small areas of the finer textured Mayberry and Sharpsburg soils and of the Sogn soils, which are shallow over limestone. Mayberry soils are in lower positions and formed in glacial till. Sharpsburg soils are on higher parts of side slopes. Sogn soils are steeper and are on lower parts of side slopes. Included soils make up 10 to 20 percent of the unit.

Permeability is moderately slow, and the available water capacity is high. Runoff is rapid. Organic matter content is moderately low, and natural fertility is medium. Tilth is fair. The shrink-swell potential is moderate.

Most of the acreage of this soil is cultivated. A few areas are in grass or trees and are used for grazing.

This soil is poorly suited to corn, grain sorghum, soybeans, wheat, and alfalfa. It is best suited to close-growing crops, but row crops can be grown if a high level of management adequately controls erosion. The hazard of water erosion is severe. Terraces, grassed waterways, and contour farming help to control erosion and conserve surface water. Returning crop residue to the soil helps to maintain and improve organic matter content.

This soil is poorly suited to sprinkler irrigation, but corn, grain sorghum, and alfalfa can be grown in irrigated areas. Erosion is the main hazard. Irrigation water should be applied at the proper time and in the proper amounts. Conservation tillage practices that keep crop residue on the surface help to control erosion and runoff. Terraces, grassed waterways, and contour farming also help to control erosion.

This soil is suited to grasses and legumes for pasture and hay, which are effective in controlling erosion. Pastures commonly consist of smooth brome or a mixture of smooth brome and alfalfa. Gully and rill erosion can be hazards in overgrazed pasture. Proper stocking, timely mowing, rotation grazing, and fertilizing help to keep the grass and soil in good condition.

This soil is suited to trees and shrubs in windbreaks. Survival of adapted species is good, and growth is fair. Competition for moisture from weeds and grasses can be eliminated by cultivating between the rows and by hand hoeing, rototilling, or using appropriate herbicides in the row. Contour planting and terraces help to prevent erosion and excessive runoff.

The moderately slow permeability of this soil is a limitation for septic tank absorption fields but can generally be overcome by increasing the size of the absorption field. For proper operation of septic tank absorption fields, the land must be reshaped and the lines laid on the contour. Foundations for dwellings can be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. Dwellings need to be designed to fit the slope, or the soil can be graded to an acceptable slope. The surface pavement and base material of roads and streets should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. 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 soil is in capability units IVe-8 dryland and IVe-4 irrigated, Silty range site, and windbreak suitability group 3.

Ha—Haynie silt loam, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is on bottom lands along major rivers. The soil formed in alluvium. Some areas are protected by dikes, but some are subject to occasional flooding. Individual areas range from small, narrow strips of about 10 acres to broad areas of more than several hundred acres.

Typically, the surface layer is very dark grayish brown, very friable, calcareous silt loam about 7 inches thick. The underlying material is stratified, calcareous silt loam and very fine sandy loam to a depth of 60 inches. The underlying material is mostly dark grayish brown with thin strata of very dark grayish brown and dark brown, and it commonly has yellowish brown mottles. In some places, the underlying material has thin strata of silty clay loam.

Included with this soil in mapping are small areas of the clayey Onawa soils and the sandy Sarpy soils. These soils make up 5 to 15 percent of the map unit.

Permeability is moderate, and available water capacity is high. Moisture is readily released to plants. Runoff is slow. This soil dries quickly after rains, and it can be worked through a wide range of moisture content. Organic matter content is moderate, and natural fertility is high.

Most of the acreage of this soil is cultivated. A few areas along former drainageways are in grass or trees.

This soil is suited to corn, grain sorghum, soybeans, small grains, and alfalfa. Row crops can be grown several years in succession. The occasional flooding can be controlled by diversions and dikes on the flood plain. Conservation tillage practices that leave crop residue on the surface help to control wind erosion and conserve moisture. Applying fertilizer helps to maintain fertility.

Under irrigation, this soil is suited to corn, soybeans, grain sorghum, alfalfa, and green forage crops. Leveling is generally needed for efficient water use in a gravity system. Sprinkler irrigation is well suited to this soil.

This soil is suited to grasses and is used for pasture or hay. Pastures commonly consist of smooth brome and other introduced grasses. A legume in the grass mixture will increase forage production. Proper stocking, rotation grazing, and fertilizing help to keep the grasses vigorous.

This soil is suited to the trees and shrubs in windbreaks. Survival of adapted species is good. Competition for moisture from weeds and grasses is a concern in management. Weeds and grasses can be controlled by cultivation with conventional equipment between the rows and by hand hoeing, rototilling, and using appropriate herbicides in the tree rows.

Unprotected areas of this soil are not suitable for dwelling sites or septic tank absorption fields because of flooding. In areas that are protected by dikes, the soil is generally suited to such uses. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. Damage to roads and streets by frost action can be reduced by providing good surface drainage. Crowning the road by grading helps to provide the needed surface drainage. Constructing roads on suitable, well compacted fill material above flood level and providing adequate side ditches and culverts help to protect the roads from flood damage.

This soil is in capability units IIw-3 dryland and IIw-6 irrigated, Silty Lowland range site, and windbreak suitability group 1L.

HdF—Hedville sandy loam, 6 to 20 percent slopes. This shallow and very shallow, strongly sloping to steep, somewhat excessively drained soil is on side slopes of drainageways. The soil formed in material weathered from sandstone. Areas of this soil range from 3 to 10 acres in size.

Typically, the surface layer is very dark grayish brown, friable sandy loam about 10 inches thick. The subsurface layer is dark brown, friable sandy loam about 5 inches thick. Below this is yellowish brown sandstone.

Included with this soil in mapping are small areas of sandstone outcrops. In places, depth to sandstone is as much as 40 inches. Included areas make up about 10 percent of the unit.

Permeability is moderate above the bedrock. Available water capacity is very low. Runoff is medium or rapid. Organic matter content is moderate, and natural fertility is low. The sandstone bedrock restricts root penetration and limits water movement.

Nearly all of the acreage of this soil is in trees and native grass. It is used mainly for wildlife habitat and range.

This soil is generally unsuited to cultivated crops and poorly suited to introduced grass pasture because of steep slope and shallow depth to rock.

This soil is suited to native grasses and is used for range, which conserves moisture and reduces erosion. Overgrazing by livestock reduces the protective cover and causes deterioration of the potential natural vegetation. Proper grazing use, deferred grazing, and a planned grazing system help to maintain or improve the range condition.

This soil is generally not suited to windbreaks. However, trees and shrubs can be planted by hand in some areas for recreational purposes or for wildlife habitat. Bur oak, red oak, and cedar are the wild trees that grow on this soil.

This soil is generally unsuitable for septic tank absorption fields or dwelling sites because of the shallow depth to bedrock and steep slopes. Other sites should be found. Cuts and fills are generally needed to provide a suitable grade for roads. However, construction is difficult because of the shallow bedrock. Blasting may be needed to break up the sandstone.

This soil is in capability unit VIs-4 dryland, Shallow Sandy range site, and windbreak suitability group 10.

IdF—Ida silt loam, 17 to 30 percent slopes. This deep, steep, somewhat excessively drained soil is on upland side slopes and narrow ridgetops. The soil formed in calcareous loess. Individual areas range from 4 to 40 acres in size.

Typically, the surface layer is dark grayish brown, very friable silt loam about 7 inches thick. The underlying material is calcareous silt loam to a depth of 60 inches; it is dark yellowish brown in the upper part and yellowish brown in the lower part with relict mottles.

Included with this soil in mapping are small areas of Monona soils. Monona soils have a thicker, darker colored surface layer and a subsoil. They are generally in the less sloping areas. Gullies and small rills are common in some areas. Included areas make up about 10 percent of the unit.

Permeability is moderate, and available water capacity is high. Runoff is rapid. Organic matter content and natural fertility are low.

Most of the acreage of this soil is in range. This soil is generally not suited to cultivation or to tame grasses because of the steep slope. Some areas are used for pasture; smooth brome is the main grass.

This soil is suited to range. Maintaining a good cover of native grasses controls erosion. Leaving half or more of the vegetation each year at the end of the growing season helps to maintain a thick stand of grass. Overgrazing by livestock reduces the protective cover and causes deterioration of the natural vegetation. Proper grazing use, deferred grazing, and a planned grazing system help to maintain or improve the range condition.

This soil is not suited to trees and shrubs in windbreaks because of steepness of slope and the excessive hazard of erosion. Trees and shrubs can be planted by hand for wildlife habitat.

This soil is generally not suitable for septic tank absorption fields because of the steep slope. Other sites should be found. Dwellings need to be designed to fit the slope, or the soil can be graded to an acceptable slope. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. Cuts and fills are generally needed to provide a suitable grade for roads and streets. Damage to roads and streets by frost action can be reduced by providing good surface drainage. Crowning the road by grading helps to provide the needed surface drainage.

This soil is in capability unit VIe-9 dryland, Limy Upland range site, and windbreak suitability group 10.

Ju—Judson silt loam, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is on foot slopes. The soil formed in silty sediment eroded mostly from dark colored soils. Individual areas range from 5 to 30 acres in size.

Typically, the surface layer is very dark brown, friable silt loam about 7 inches thick. The subsurface layer is about 22 inches thick. The upper part of the subsurface layer is very dark brown, friable silt loam; the middle part is very dark grayish brown, friable silty clay loam; and the lower part is dark brown, friable silty clay loam. The subsoil is friable silty clay loam about 20 inches thick; it is dark brown in the upper part and dark yellowish brown in the lower part. The underlying material is dark yellowish brown silty clay loam to a depth of 60 inches. In some places, there is less clay in the lower part of the profile.

Included with this soil in mapping are small areas of Colo and Nodaway soils. Colo soils are somewhat poorly drained and are at lower positions. Nodaway soils are in natural drainageways and are occasionally flooded. Included areas make up about 10 percent of the unit.

Permeability is moderate, and available water capacity is high. Runoff is slow. Organic matter content and natural fertility are high. This soil is easily tilled through a fairly wide range in moisture content.

Most of the acreage of this soil is cultivated. A few small areas are used for pasture or hay.

This soil is suited to corn, grain sorghum, soybeans, and wheat. Row crops can be grown several years in succession if weeds, insects, and plant diseases are controlled. Conservation tillage practices that leave crop residue on the surface help to conserve soil moisture. Returning crop residue and green manure crops to the soil helps to maintain and improve the organic matter content and increases intake of water. The use of fertilizer or legumes helps to maintain fertility.

This soil is suited to gravity and sprinkler irrigation. Corn, grain sorghum, alfalfa, and soybeans can be grown in irrigated areas. Irrigation water should be applied at the proper time and in the proper amounts.

This soil is suited to grasses and legumes for pasture and hay. Smooth brome, orchardgrass, and reed canarygrass grow well on this soil. Proper stocking, timely mowing, rotation grazing, and fertilizing help to keep the grass and soil in good condition.

This soil is suited to trees and shrubs in windbreaks. Weeds and grasses can be controlled by cultivation with conventional equipment between the rows and by hand hoeing, rototilling, and using appropriate herbicides in the tree rows.

This soil is generally suited to septic tank absorption fields. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve 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 soil is in capability units I-1 dryland and I-4 irrigated, Silty range site, and windbreak suitability group 1.

JuC—Judson silt loam, 2 to 6 percent slopes. This deep, gently sloping, well drained soil is on foot slopes. The soil formed in silty sediment eroded mostly from dark colored soils. Areas are long and narrow and range from 5 to 200 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 6 inches thick. The subsurface layer is about 28 inches thick; it is very dark grayish brown, friable silt loam in the upper part and very dark brown, friable silty clay loam in the lower part. The subsoil is dark brown, friable silty clay loam to a depth of 60 inches.

Included with this soil in mapping are small areas of Colo and Nodaway soils. Poorly drained Colo soils are at lower positions. Nodaway soils are in natural drainageways and are occasionally flooded. Included areas make up about 10 percent of the unit.

Permeability is moderate, and available water capacity is high. Runoff is medium. Organic matter content and natural fertility are high. This soil is easily tilled through a fairly wide range of moisture content.

Most of the acreage of this soil is cultivated. Small tracts are in grass and are used for pasture.

This soil is suited to corn, grain sorghum, soybeans, and wheat. Farming on the contour helps to control erosion and runoff. Diversion terraces can protect this soil from concentrated runoff from nearby uplands. Conservation tillage practices that leave crop residue on the soil surface help to conserve soil moisture. Returning crop residue and green manure crops to the soil helps to maintain and improve the organic matter content and increase the intake of water. The use of fertilizer or legumes helps to maintain fertility.

This soil is suited to sprinkler irrigation. Corn, alfalfa, grain sorghum, and soybeans can be grown in irrigated areas. Irrigation water should be applied at the proper time and in proper amounts.

This soil is suited to grasses and legumes for pasture or hay. Smooth brome and orchardgrass grow well in this soil. Proper stocking, timely mowing, rotation grazing, and fertilizing help to keep the grass and soil in good condition.

This soil is suited to trees and shrubs in windbreaks. Competition for moisture from weeds and grasses can be controlled by cultivating between the rows with conventional equipment. Careful use of appropriate herbicides in the row also helps to control undesirable weeds and grasses, or areas in the row or near small trees can be hoed by hand or rototilled.

This soil is generally suited to septic tank absorption fields. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve 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 soil is in capability units IIe-1 dryland and IIIe-4 irrigated, Silty range site, and windbreak suitability group 3.

Ke—Kennebec silt loam, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is on bottom lands. The soil formed in alluvium. It is occasionally flooded. Individual areas range from 4 to 150 acres in size.

Typically, the surface layer is very dark gray, friable silt loam about 6 inches thick. The subsurface layer is black, friable silt loam about 27 inches thick. The next layer is about 9 inches of black, friable silt loam. The underlying stratified material is black, dark gray, very dark grayish brown, and light brownish gray silt loam to a depth of 60 inches. In some places, a buried soil is at a depth of more than 30 inches.

Included with this soil in mapping are small areas of Colo and Judson soils. Colo soils are somewhat poorly drained and are at slightly lower positions. Judson soils are well drained and are at higher positions. Included areas make up about 10 percent of the unit.

Permeability is moderate, and available water capacity is high. Runoff is slow. The seasonal high water table rises to a depth of about 3 feet in wet years and 5 feet in dry years. Organic matter content and natural fertility are high. This soil is easily tilled through a fairly wide range in moisture content. The shrink-swell potential is moderate.

Most of the acreage of this soil is cultivated.

This soil is suited to corn, grain sorghum, soybeans, and wheat. Row crops can be grown several years in succession. Conservation tillage practices that leave crop residue on the surface help to conserve soil moisture. Returning crop residue and green manure crops to the soil helps to maintain organic matter content and increases intake of water. The use of fertilizer or legumes helps to maintain fertility.

Under irrigation, this soil is suited to corn, alfalfa, grain sorghum, and soybeans. Water can be applied by gravity or sprinkler systems. Applications of irrigation water should be timely and in proper amounts. Applying barnyard manure and crop residue improves infiltration of water on areas that have been disturbed during land leveling operations.

This soil is suited to grasses and legumes for pasture and hay. Smooth brome, orchardgrass, and reed canarygrass grow well in this soil. Proper stocking, timely mowing, rotation grazing, and fertilizing help to keep the grass and soil in good condition.

This soil is suited to trees and shrubs in windbreaks. Weeds and grasses can be controlled by cultivation with conventional equipment between the rows and by hand hoeing, rototilling, and using appropriate herbicides in the tree rows.

This soil is not suitable for septic tank absorption fields and dwelling sites because of flooding and wetness. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. Constructing roads on suitable, well compacted fill material above flood level and providing adequate side ditches and culverts help to protect the roads from flood damage. Damage to roads 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 soil is in capability units I-1 dryland and I-6 irrigated, Silty Lowland range site, and windbreak suitability group 1.

MaC—Marshall silty clay loam, 2 to 5 percent slopes. This deep, gently sloping, well drained soil is on wide ridgetops and upland side slopes. The soil formed in loess. Individual areas range from 5 to 80 acres in size.

Typically, the surface layer is very dark brown, friable silty clay loam about 6 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 8 inches thick. The subsoil is friable silty clay loam about 31 inches thick; the upper part is dark brown, and the lower part is dark yellowish brown. The underlying material is yellowish brown, mottled silty clay loam to a depth of 60 inches. In some places, the surface horizon is thinner. In some areas, the subsoil has more clay.

Included with this soil in mapping are small areas of Judson soils along drainageways. Judson soils have a thicker surface soil. Included areas make up about 5 percent of the unit.

Permeability is moderate, and available water capacity is high. Moisture is released readily to plants. Runoff is medium. This soil dries readily after rains and is easily worked through a fairly wide range of moisture content. Organic matter content is moderate, and natural fertility is high. The shrink-swell potential is moderate.

Most of the acreage of this soil is cultivated.

This soil is suited to corn, grain sorghum, soybeans, wheat, and alfalfa. Water erosion is the main problem.

Terraces, grassed waterways, and contour farming help to control erosion and runoff. Returning crop residue to the soil increases intake of water and helps to maintain organic matter content. The use of fertilizer or legumes helps to maintain fertility.

Sprinkler irrigation is suitable. Corn, alfalfa, grain sorghum, and soybeans can be grown in irrigated areas. Irrigation water should be applied at the proper time and in proper amounts. Maintaining crop residue on the surface reduces runoff and increases water intake.

This soil is suited to grasses and legumes for pasture and hay. Smooth brome is commonly grown on this soil. A legume will increase forage production. Fertilizer should be applied according to soil tests. Proper stocking, timely mowing, and rotation grazing help to keep the grass in good condition.

This soil is suited to trees and shrubs in windbreaks. Survival of adapted species is good, and growth is fair. Competition for moisture from weeds and grasses can be eliminated by cultivating between the rows and by hand hoeing, rototilling, or using appropriate herbicides in the row. Planting trees and shrubs on the contour reduces erosion.

This soil is generally suited to septic tank absorption fields. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve 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 soil is in capability units IIe-1 dryland and IIIe-3 irrigated, Silty range site, and windbreak suitability group 3.

MaC2—Marshall silty clay loam, 2 to 5 percent slopes, eroded. This deep, gently sloping, well drained soil is on narrow ridgetops and upland side slopes. The soil formed in loess. Some areas have rills and small gullies formed by runoff after heavy rains. Individual areas range from 10 acres to over 200 acres in size. Erosion has removed much of the original dark surface soil over most of the area.

Typically, the surface layer is very dark brown, friable silty clay loam about 6 inches thick. The subsurface layer is dark brown, friable silty clay loam about 4 inches thick. The subsoil is friable silty clay loam about 33 inches thick; the upper part is brown, and the lower part is dark yellowish brown. The underlying material is yellowish brown silt loam to a depth of 60 inches. In some places, the dark surface layer is thicker.

Included with this soil in mapping are small areas of Judson and Sharpsburg soils. The Judson soils have a thicker surface horizon and are on foot slopes. Sharpsburg soils have more clay in the subsoil. Included areas make up about 10 percent of the unit.

Permeability is moderate, and available water capacity is high. This soil readily releases moisture to plants. Runoff is medium. This soil dries readily after rains and is easily worked through a fairly wide range of moisture content. Tilth is fair. Organic matter content is moderately low, and natural fertility is medium. The shrink-swell potential is moderate.

Most of the acreage of this soil is cultivated.

This soil is suited to corn, grain sorghum, soybeans, wheat, and alfalfa. Water erosion is the main problem. Terraces, grassed waterways, and contour farming help to control erosion and runoff (fig. 7). Returning crop residue to the soil helps to maintain organic matter content. The use of fertilizer or legumes helps to maintain fertility.

Sprinkler irrigation is suitable for this soil. Corn, alfalfa, grain sorghum, and soybeans can be grown in irrigated areas. Irrigation water should be applied at the proper time and in proper amounts. Erosion is difficult to control in irrigated areas because of the slope. Maintaining crop residue on the surface reduces runoff and increases water intake.

This soil is suited to grasses and legumes for pasture and hay. Smooth brome, orchardgrass, and tall fescue grow well. A legume is desirable in the planting. Fertilizer should be applied according to soil tests. Proper stocking, timely mowing, and rotation grazing help to keep the grass in good condition.

This soil is suited to trees and shrubs in windbreaks. Survival of adapted species is good, and growth is fair. Competition for moisture from weeds and grasses can be eliminated by cultivating between the rows and by hand hoeing, rototilling, or using appropriate herbicides in the row. Planting trees and shrubs on the contour reduces erosion.

This soil is generally suited to septic tank absorption fields. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve 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 soil is in capability units IIe-1 dryland and IIIe-3 irrigated, Silty range site, and windbreak suitability group 3.

MaD—Marshall silty clay loam, 5 to 11 percent slopes. This deep, strongly sloping, well drained soil is

Figure 7.—Terraces on Marshall silty clay loam, 2 to 5 percent slopes, eroded.

on upland side slopes. The soil formed in loess. Individual areas range from 5 to 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 6 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 7 inches thick. The subsoil is friable silty clay loam about 27 inches thick; the upper part is dark brown, the middle part is dark yellowish brown, and the lower part is yellowish brown. The underlying material is yellowish brown silt loam to a depth of 60 inches. In some places, the surface layer is thinner.

Included with this soil in mapping are small areas of Judson soils. Judson soils are on foot slopes and have a thicker surface soil. Included areas make up about 5 percent of the unit.

Permeability is moderate, and available water capacity is high. Moisture is released to plants readily. Runoff is medium. This soil dries readily after rains and is easily worked through a fairly wide range of moisture content. Organic matter content is moderate, and natural fertility is high. The shrink-swell potential is moderate.

Most areas of this soil have a dense cover of trees or grasses and are used as wooded pasture or as habitat for wildlife. A few small areas are cultivated.

This soil is suited to corn, grain sorghum, soybeans, wheat, and alfalfa. Limiting row crops and growing close-sown crops, such as small grain and alfalfa, help to control erosion and conserve water. Controlling water erosion and runoff are the main concerns in management. Terraces, grassed waterways, and contour farming help to control erosion and runoff. Returning crop residue to the soil helps to maintain organic matter content and increases intake of water. The use of fertilizer or legumes helps to maintain fertility. Lime is needed to correct soil acidity.

Sprinkler irrigation can be used. This soil is suited to irrigated corn, alfalfa, and grain sorghum. Irrigation water should be applied at the proper time and in proper amounts. Terraces, grassed waterways, and contour farming help to control erosion. Maintaining crop residue on the surface reduces runoff and increases water intake.

This soil is suited to grasses and legumes for pasture or hay. Smooth brome is commonly grown. A legume is desirable in the planting. Permanent grass is effective in controlling erosion. Fertilizer should be applied according to soil tests. Lime is needed in places to correct soil acidity. Proper stocking, timely mowing, and rotation grazing help to keep the grass and soil in good condition.

This soil is suited to trees and shrubs in windbreaks. Survival of adapted species is good, and growth is fair. Competition for moisture from weeds and grasses can be eliminated by cultivating between the rows and by rototilling or using appropriate herbicides in the row. Planting trees on the contour helps to prevent erosion. Terraces are also helpful.

For proper operation of septic tank absorption fields, the land must be reshaped and the lines laid on the contour. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. Dwellings need to be designed to fit the slope, or grading is needed to modify the slope. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve 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 soil is in capability units IIIe-1 dryland and IVe-3 irrigated, Silty range site, and windbreak suitability group 3.

MaD2—Marshall silty clay loam, 5 to 11 percent slopes, eroded. This deep, strongly sloping, well drained soil is on upland side slopes. The soil formed in loess. Rills and small gullies are common after heavy rains. Individual areas range from 5 acres to over 400 acres in size. Erosion has removed much of the original dark surface soil over most of the area.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 7 inches thick. The subsoil is friable silty clay loam about 30 inches thick; the upper part is dark brown, the middle part is brown, and the lower part is dark yellowish brown. The underlying material is dark yellowish brown silty clay loam to a depth of 60 inches. In some places, the soil is not as eroded.

Included with this soil in mapping are small areas of Judson and Sharpsburg soils. The Judson soils have a thicker surface layer and are on foot slopes. Sharpsburg soils have more clay in the subsoil. Included areas make up about 10 percent of the unit.

Permeability is moderate, and available water capacity is high. This soil releases moisture readily to plants. Runoff is medium. This soil dries readily after rains and is easily worked through a fairly wide range of moisture content. Tilth is fair. Organic matter content is moderately low, and natural fertility is medium. The shrink-swell potential is moderate.

Most of the acreage of this soil is cultivated.

This soil is suited to corn, grain sorghum, soybeans, wheat, and alfalfa. Close-growing crops are the most suitable. Row crops need a high level of management to prevent erosion. Erosion by water is the main problem. Conservation of water is an important concern in management. Terraces, grassed waterways, and contour farming help to control erosion and runoff. Returning crop residue to the soil helps to maintain organic matter content and increase the intake of water. The use of fertilizer or legumes helps to maintain fertility.

Sprinkler irrigation can be used. This soil is suited to irrigated corn, alfalfa, grain sorghum, and soybeans. Irrigation water should be applied at the proper time and in proper amounts. Terraces, grassed waterways, and contour farming help to control erosion. Maintaining crop residue on the surface reduces runoff and increases water intake.

This soil is suited to grasses and legumes for pasture or hay. Smooth brome is commonly grown. A legume is desirable in the planting. Permanent grass is effective in controlling erosion. Fertilizer should be applied according to soil tests. Rill erosion is a hazard on grassland that is overgrazed. Proper stocking, timely mowing, and rotation grazing help to keep the grass and soil in good condition.

This soil is suited to trees and shrubs in windbreaks. Survival of adapted species is good, and growth is fair. Competition for moisture from weeds and grasses can be eliminated by cultivating between the rows and by hand hoeing, rototilling, or using appropriate herbicides in the row. Planting trees on the contour helps to prevent erosion. Terraces are also helpful.

For proper operation of septic tank absorption fields, the land must be reshaped and the lines laid on the contour. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. Dwellings need to be designed to fit the slope, or the soil can be graded to an acceptable slope. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve 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 soil is in capability units IIIe-8 dryland and IVe-3 irrigated, Silty range site, and windbreak suitability group 3.

MaE2—Marshall silty clay loam, 11 to 17 percent slopes, eroded. This deep, moderately steep, well drained soil is on upland side slopes. The soil formed in loess. Rills and small gullies are common after heavy rains. Individual areas range from 5 to 80 acres in size. Erosion has removed much of the original dark surface soil over most of the area.

Typically, the surface layer is dark brown, friable silty clay loam about 5 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 3 inches thick. The subsoil is friable silty clay loam about 19 inches thick; it is dark brown in the upper part, brown in the middle part, and dark yellowish brown in the lower part. The underlying material is yellowish brown silty clay loam to a depth of 60 inches. In some places, the soil is not as eroded.

Included with this soil in mapping are small areas of Judson and Nodaway soils. Judson soils are on foot slopes and have a thicker surface soil. Nodaway soils are along drainageways and are frequently flooded. Included areas make up about 10 percent of the unit.

Permeability is moderate, and available water capacity is high. Moisture is readily available to plants. Runoff is rapid. This soil dries readily after rains and is easily worked through a fairly wide range of moisture content. Tilth is fair. Organic matter content is moderately low, and natural fertility is medium. The shrink-swell potential is moderate.

Most of the acreage of this soil is cultivated. Some areas are in grass and trees and are used for grazing.

This soil is poorly suited to corn, grain sorghum, soybeans, wheat, and alfalfa. It is best suited to close-growing crops. Erosion and runoff are the main problems. Terraces help to control erosion and conserve surface water. Contour farming and grassed waterways help to control erosion. Returning crop residue to the soil helps to maintain and improve the organic matter content.

This soil is suited to grasses and legumes for pasture and hay. Pastures commonly consist of smooth brome. A legume should be planted with the grasses. Pasture is effective in controlling erosion. Fertilizer should be applied according to soil tests. Gullying and rill erosion are hazards in overgrazed pasture. Proper stocking, timely mowing, rotation grazing, and fertilizing help to keep the grasses and soil in good condition.

This soil is suited to trees and shrubs in windbreaks. Survival of adapted species is good and growth is fair if competition for moisture from weeds and grasses is eliminated by cultivating between the rows and by hand hoeing, rototilling, or using appropriate herbicides in the row. Contour planting and terraces help to prevent erosion and excessive runoff. Growth may be somewhat slower in the steepest areas.

For proper operation of septic tank absorption fields, the land must be reshaped and the lines laid on the contour. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. Dwellings need to be designed to fit the slope, or the soil can be graded to an acceptable slope. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve 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 soil is in capability unit IVe-8 dryland, Silty range site, and windbreak suitability group 3.

MeD2—Mayberry silty clay loam, 6 to 11 percent slopes, eroded. This deep, strongly sloping, moderately well drained soil is on upland side slopes. The soil formed in material reworked from glacial deposits. Individual areas range from 3 to 40 acres in size. Erosion has removed much of the original dark surface layer over most of the area.

Typically, the surface layer is dark brown, friable silty clay loam about 6 inches thick. The subsoil is dark brown, firm clay about 44 inches thick. The underlying material is yellowish brown, mottled clay loam to a depth of 60 inches.

Included with this soil in mapping are small areas of Geary, Morrill, Pawnee, and Wymore soils. Geary and Morrill soils have less clay in the subsoil. Pawnee soils are not as reddish brown as Mayberry soils and are at lower positions. Wymore soils formed in loess and are at higher positions. Included soils make up 5 to 20 percent of the unit.

Permeability is slow, and available water capacity is moderate. Water is released slowly to plants. Runoff is rapid. A perched seasonal high water table is at a depth of 1 to 3 feet in spring of some years. Natural fertility is medium, and organic matter content is moderately low. The clayey subsoil somewhat limits root penetration and restricts water movement. Tilth is poor. The shrink-swell potential is high.

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

This soil is poorly suited to row crops. Small grains, legumes, and grain sorghum are commonly grown. The main concern in management is controlling runoff and erosion. Growing mostly close-sown crops, such as legumes and grasses, helps to control erosion. Terraces, grassed waterways, contour farming, and use of crop residue as mulch also help to control runoff and erosion. During dry seasons this soil becomes hard, develops cracks, and is droughty. Organic matter content and tilth can be improved or maintained by returning crop residue to the soil.

This soil is suited to native grasses and legumes for pasture or hay. This use is effective in controlling erosion if the grasses are properly managed. Fertilizer should be applied according to soil tests. Proper stocking, timely mowing, and rotation grazing help to keep the grass and soil in good condition.

This soil is poorly suited to trees and shrubs in windbreaks. Drought and moisture competition from weeds and grasses are the principal problems. This soil absorbs and releases moisture too slowly to sustain good tree growth. Planting windbreaks on the contour helps to control erosion.

This soil is not suitable for septic tank absorption fields because of slow permeability. Other sites should be found. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. Constructing dwellings on raised, well compacted fill material helps to avoid wetness caused by the seasonal high water table. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. Damage to roads 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. Mixing the base material for roads and streets with additives, such as hydrated lime, helps to prevent shrinking and swelling.

This soil is in capability unit IVe-2 dryland, Clayey range site, and windbreak suitability group 4C.

MnC—Monona silt loam, 2 to 5 percent slopes. This deep, gently sloping, well drained soil is on divides and ridgetops on the uplands. The soil formed in loess. Individual areas range from 10 to 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 6 inches thick. The subsurface layer also is very dark grayish brown, friable silt loam about 6 inches thick. The subsoil is friable silt loam about 23 inches thick; it is dark brown in the upper part and dark yellowish brown in the lower part. The underlying material is yellowish brown silt loam to a depth of 60 inches. In some areas the surface layer is thinner. In places the subsoil is silty clay loam.

Permeability is moderate, and available water capacity is high. Moisture is readily released to plants. Runoff is medium. Organic matter content is moderate, and natural fertility is high. This soil dries quickly after rains, and it is easily worked through a wide range of moisture content.

Most of the acreage of this soil is cultivated, but a few areas are used for pasture.

This soil is suited to corn, grain sorghum, soybeans, and wheat. Row crops can be grown in consecutive years if a high level of management is used. Erosion and loss of moisture through runoff are the principal hazards. Terraces and grassed waterways conserve moisture and reduce erosion. Conservation tillage and returning crop residue to the soil help to maintain organic matter content and intake of water. Fertilizer, used according to soil tests, and legumes in the cropping sequence help to maintain fertility.

This soil is suited to sprinkler irrigation. Suitable crops include corn, alfalfa, grain sorghum, and soybeans. Irrigation water should be applied at the proper time and in proper amounts. Maintaining crop residue on the surface reduces runoff and increases water intake.

This soil is suited to grasses and legumes for pasture and hay. Pastures commonly consist of smooth brome or a mixture of smooth brome and alfalfa. Proper stocking, timely mowing, rotation grazing, and fertilizing help to keep the grasses in good condition.

This soil is suited to trees and shrubs in windbreaks. Survival of seedlings is good and growth is fair if moisture is conserved and weedy vegetation is controlled or removed by cultivating between rows with conventional equipment. Areas in the row or near small trees can be hoed by hand, rototilled, or sprayed with appropriate herbicides. Terraces and contour planting reduce runoff and conserve moisture.

This soil is generally suited to septic tank absorption fields. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. Damage to roads and streets by frost action can be reduced by providing good surface drainage. Crowning the road by grading helps to provide the needed surface drainage.

This soil is in capability units IIe-1 dryland and IIIe-4 irrigated, Silty range site, and windbreak suitability group 3.

MnD2—Monona silt loam, 5 to 11 percent slopes, eroded. This deep, strongly sloping, well drained soil is on upland side slopes. The soil formed in loess. Individual areas range from 5 to 80 acres in size. Erosion has removed much of the original dark surface soil over most of the area.

Typically, the surface layer is very dark grayish brown, friable silt loam about 6 inches thick. The subsurface layer is dark brown, friable silt loam about 3 inches thick. The subsoil is friable silt loam about 19 inches thick; the upper part is brown, and the lower part is dark yellowish brown. The underlying material is mottled silt loam to a depth of 60 inches; it is dark yellowish brown in the upper part and yellowish brown in the lower part. In some areas, the soil is eroded less. In places the subsoil contains more clay.

Included with this soil in mapping are small areas of steeper Ida soils. Included areas make up about 5 percent of the unit.

Permeability is moderate, and available water capacity is high. Runoff is rapid. Organic matter content is moderately low, and natural fertility is medium.

Most of the acreage of this soil is cultivated. A few small areas are in pasture or hay.

This soil is suited to corn, grain sorghum, soybeans, and wheat. Close-growing crops are the most suitable. Row crops need a high level of management to prevent erosion. Erosion by water is the main hazard. Water conservation is also important. Terraces and grassed waterways reduce runoff and conserve moisture. Conservation tillage and contour farming also reduce erosion and conserve moisture. Returning crop residue to the soil increases the organic matter content and intake of water.

This soil is suited to grasses and legumes for pasture and hay. Pastures commonly consist of smooth brome or a mixture of smooth brome and alfalfa. Proper stocking, timely mowing, rotation grazing, and fertilizing help to keep the grasses vigorous.

This soil is suited to trees and shrubs in windbreaks. Survival of seedlings is good and growth is fair if competition from grasses and weeds is controlled by cultivating between rows, hoeing by hand, rototilling, or using proper herbicides. Lack of sufficient moisture caused by runoff can reduce growth of trees and survival of seedlings. Terraces and contour planting reduce runoff and conserve moisture.

For proper operation of septic tank absorption fields, the land should be reshaped and the lines laid on the contour. Foundations for dwellings need to be designed to fit the slope, or grading is needed to modify the slope. The surface pavement and base material of roads should be thick enough to compensate for 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 soil is in capability unit IIIe-8 dryland, Silty range site, and windbreak suitability group 3.

MnE2—Monona silt loam, 11 to 17 percent slopes, eroded. This deep, moderately steep, well drained soil is on upland side slopes and narrow ridgetops. The soil formed in loess. Individual areas range from 5 to 60 acres in size. Erosion has removed much of the original dark surface soil over most of the area.

Typically, the surface layer is dark brown, very friable silt loam about 6 inches thick. The subsoil is very friable silt loam about 21 inches thick; it is brown in the upper part and dark yellowish brown in the lower part. The underlying material is yellowish brown silt loam to a depth of 60 inches. In some places, the dark surface layer is thicker.

Included with this soil in mapping are small areas of steeper Ida soils. Included areas make up about 10 percent of the unit.

Permeability is moderate, and available water capacity is high. Runoff is rapid. Organic matter content is moderately low, and natural fertility is medium. The shrink-swell potential is moderate.

Most of the acreage of this soil is cultivated. A few small areas are in pasture or hay.

This soil is poorly suited to corn, grain sorghum, soybeans, and wheat. It is best suited to close-growing crops, but row crops can be grown if a high level of management adequately controls erosion. The hazard of water erosion is severe. Conservation of water is important. Terraces and grassed waterways reduce runoff and conserve moisture. Conservation tillage and contour farming also reduce erosion and conserve moisture. Returning crop residue to the soil increases organic matter content and intake of water.

This soil is suited to grasses and legumes for pasture and hay, which control erosion. Pastures commonly consist of smooth brome or a mixture of smooth brome and alfalfa. Proper stocking, timely mowing, rotation grazing, and fertilizing help to keep the grasses vigorous.

This soil is suited to trees and shrubs in windbreaks. Survival of seedlings is good and growth is fair if competition from grasses and weeds is controlled by cultivating between rows, hand hoeing, rototilling, or using proper herbicides. Contour planting and terraces reduce runoff and erosion. Growth may be somewhat slower in the steepest areas.

For proper operation of septic tank absorption fields, the land should be reshaped and the lines laid on the contour. Foundations for dwellings need to be designed to fit the slope, or grading is needed to modify the slope. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. 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 unit IVe-8 dryland, Silty range site, and windbreak suitability group 3.

MnF—Monona silt loam, 17 to 30 percent slopes. This deep, steep, somewhat excessively drained soil is on upland side slopes. The soil formed in loess. Individual areas range from 10 acres to over 300 acres in size.

Typically, the surface layer is very dark grayish brown, very friable silt loam about 8 inches thick. The subsurface layer is very dark grayish brown, friable silt loam about 4 inches thick. The subsoil is friable silt loam about 24 inches thick; it is dark brown in the upper part and dark yellowish brown in the lower part. The underlying material is yellowish brown silt loam to a depth of 60 inches. In some places, the subsoil and underlying material are very fine sandy loam. In some places, the soil has more clay in the subsoil.

Included with this soil in mapping are small areas of Ida and Nodaway soils. The calcareous Ida soils are on narrow ridgetops. The frequently flooded Nodaway soils are on bottom lands of the wider drainageways. Included areas make up about 10 percent of the unit.

Permeability is moderate, and available water capacity is high. Runoff is very rapid. Organic matter content is moderate, and natural fertility is medium.

Most areas of this soil have a dense cover of trees. Some areas are mixed grasses and trees and are used for grazing.

This soil is generally not suited to crops because of slope and the very severe hazard of water erosion.

This soil is suited to range, which is effective in controlling water erosion. Steepness limits the use of farm machinery for haying. Overgrazing by livestock can harm the protective cover of native plants. Overgrazing also can result in severe soil losses to water erosion. Proper grazing, timely deferment from grazing, and a planned grazing system help to keep the range and soil in good condition.

Tree windbreaks are generally not needed because most areas are in native hardwoods. The naturally occurring trees, associated grasses, and wild herbaceous plants provide good cover and food for wildlife.

Recreation development is generally limited by the steep slope. Camp sites, picnic areas, and playgrounds should be located on adjacent soils that are not as steep or on areas that have been shaped and leveled. Paths and trails should lie on the contour along ridgetops.

This soil is generally not suitable for sanitary facilities because of steepness. Other sites should be found. Dwellings need to be designed to fit the slope. Roads should be designed so that surface drainage is not concentrated on unprotected and erodible areas. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve stability. Cuts and fills are generally needed to provide a suitable grade for roads and streets, and erosion control is a major concern.

This soil is in capability unit VIe-1 dryland, Silty range site, and windbreak suitability group 10.

MoE2—Monona-Ida silt loams, 11 to 17 percent slopes, eroded. These deep, moderately steep, well drained soils are on upland side slopes and narrow ridgetops. These soils formed in loess. Individual areas range from 5 acres to over 100 acres in size. This complex is 45 to 70 percent Monona soil and 30 to 55 percent Ida soil. The two soils are in areas so intricately mixed that it was not practical to separate them in mapping. Erosion has removed much of the original surface soil and, in places, part of the subsoil. In some areas of the Monona soil, the remaining part of the surface layer has been mixed with part of the subsoil by tillage.

Typically, the Monona soil has a surface layer of dark brown, very friable silt loam about 6 inches thick. The subsurface layer is dark brown, very friable silt loam about 3 inches thick. The subsoil is very friable silt loam about 23 inches thick; the upper part is dark brown, and the lower part is dark yellowish brown. The underlying material is yellowish brown silt loam to a depth of 60 inches.

Typically, the Ida soil has a surface layer of dark brown, very friable silt loam about 6 inches thick. The underlying material is calcareous silt loam to a depth of 60 inches; it is dark yellowish brown in the upper part, yellowish brown in the middle part, and brown in the lower part. In some places the underlying material is reddish brown.

Permeability is moderate in the Monona and Ida soils. Available water capacity is high. Moisture is released to plants readily. Runoff is rapid. Organic matter content is moderately low and natural fertility is medium in the Monona soil. Organic matter content and natural fertility are low in the Ida soil. These soils are easily worked.

Most of the acreage of this map unit is cultivated. A few small areas are in pasture or hay.

These soils are poorly suited to corn, grain sorghum, soybeans, and wheat. They are best suited to close-growing crops, but row crops can be grown if a high level of management adequately controls erosion. The hazard of water erosion is severe. Conservation of water is important. Terraces and grassed waterways reduce runoff and conserve moisture. Conservation tillage and contour farming also reduce erosion and conserve moisture. Returning crop residue to the soil increases organic matter content and intake of water.

These soils are suited to grasses and legumes for pasture and hay, which effectively control erosion. Pastures commonly consist of smooth brome or a mixture of smooth brome and alfalfa. Proper stocking, rotation grazing, timely mowing, and fertilizing help to keep the grass in good condition.

These soils are suited to trees and shrubs in windbreaks. Survival of seedlings is good on the Monona soil and fair on the Ida soil. Growth is fair if competition from grasses and weeds is controlled by cultivating between rows and hand hoeing, rototilling, or using proper herbicides in the rows. Contour planting and terraces reduce runoff and erosion.

For proper operation of septic tank absorption fields, the land should be reshaped and the lines laid on the contour. Dwellings and small buildings need to be designed to fit the slope, or grading is needed to modify the slope. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve stability. Damage to roads and streets by frost action can be reduced by providing good surface drainage. Crowning the road by grading and constucting adequate side ditches help to provide the needed surface drainage. Erosion of ditchbanks and side slopes along roads can be severe; an adequate cover of grass helps to prevent erosion.

Both soils are in capability unit IVe-8 dryland. The Monona soil is in Silty range site and windbreak suitability group 3. The Ida soil is in Limy Upland range site and windbreak suitability group 8.

MoG—Monona-Ida silt loams, 30 to 60 percent slopes. These deep, very steep, excessively drained soils are on upland side slopes. These soils formed in loess. In some areas the slope is nearly vertical. Individual areas range from 10 to over 200 acres in size. This complex is 50 to 75 percent Monona soil and 25 to 45 percent Ida soil. The Monona soil is on plane or concave side slopes, and the Ida soil is on the narrow ridgetops and convex side slopes.

Typically, the Monona soil has a surface layer of very dark grayish brown, friable silt loam about 6 inches thick. The subsurface layer is dark brown, friable silt loam about 4 inches thick. The subsoil is dark yellowish brown, friable silt loam about 17 inches thick. The underlying material is dark yellowish brown silt loam to a depth of 60 inches.

Typically, the Ida soil has a surface layer of dark brown, friable silt loam about 2 inches thick. Below this is a layer of dark yellowish brown, friable silt loam about 3 inches thick. The underlying material is calcareous silt loam to a depth of 60 inches; it is dark yellowish brown in the upper part and yellowish brown in the lower part.

Included with these soils in mapping are small areas of bedrock outcrops and glacial till. The included areas make up about 5 percent of the unit.

Permeability is moderate in the Monona and Ida soils. Available water capacity is high. Runoff is very rapid. Because of the very steep slope, the hazard of water erosion is very severe. The organic matter content is moderate and natural fertility is medium in the Monona soil. The organic matter content and natural fertility are low in the Ida soil.

Most areas of these soils are wooded, and many are used for grazing.

These soils are not suited to crops because of the very severe hazard of water erosion and the excessive slope.

These soils are suited to range, which is effective in reducing water erosion. Overgrazing by livestock harms the protective cover of native plants. Overgrazing can also result in severe soil losses to water erosion. Proper grazing use, timely deferment from grazing, and a planned grazing system help to keep the range in good condition.

Tree windbreaks are generally not needed because most areas are in native hardwoods. The naturally occurring hardwoods, conifers, associated grasses, and wild herbaceous plants provide good cover and food for wildlife.

These soils are not suitable for sanitary facilities or dwellings because of the very steep slope. Other sites should be found. Roads need good surface drainage to reduce damage by frost action. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. Cuts and fills are generally needed to provide a suitable grade for roads. Erosion of ditchbanks and side slopes along roads can be severe; an adequate cover of grass helps to prevent this erosion.

Both soils are in capability unit VIIe-1 dryland and windbreak suitability group 10. The Monona soil is in Silty range site, and the Ida soil is in Limy Upland range site.

MrD2—Morrill clay loam, 6 to 11 percent slopes, eroded. This deep, strongly sloping, well drained soil is on upland side slopes. The soil formed in material reworked from glacial deposits. Individual areas range from 3 to 30 acres in size. Erosion has removed much of the original dark surface layer over most of the area.

Typically, the surface layer is dark brown, friable clay loam about 7 inches thick. The subsoil is brown, friable clay loam about 38 inches thick. The underlying material is brown clay loam to a depth of 60 inches.

Included with this soil in mapping are small areas of Burchard, Judson, Mayberry, and Sharpsburg soils. Burchard soils are on steep side slopes. Judson soils are dark colored and are on foot slopes. Mayberry and Sharpsburg soils have more clay in the subsoil. Sharpsburg soils are at higher positions. Included soils make up 10 to 20 percent of the unit.

Permeability is moderately slow, and available water capacity is high. Moisture is released to plants readily. Runoff is rapid. Organic matter content is moderately low, and natural fertility is medium. The shrink-swell potential is moderate.

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

This soil is poorly suited to corn, grain sorghum, soybeans, wheat, and alfalfa. Limiting consecutive row crops and growing close-sown crops, such as small grains and alfalfa, help to control erosion and conserve water. Terraces, contour farming, grassed waterways, and the use of crop residue as a mulch help to reduce runoff and control erosion.

This soil is poorly suited to sprinkler irrigation, but corn, grain sorghum, alfalfa, and soybeans can be grown in irrigated areas. Erosion is the main hazard. Irrigation water should be applied at the proper time and in the proper amounts. Conservation tillage practices that keep crop residue on the surface help to control erosion and reduce runoff. Terraces, grassed waterways, and contour farming also help to control erosion.

This soil is suited to grasses, which help to control erosion. Introduced grasses, such as smooth brome, need fertilizer. Proper stocking, timely mowing, rotation grazing, and fertilizing help to keep the grass and soil in good condition.

This soil is suitable for windbreaks. Survival and growth of adapted species are good. Weeds and grasses can be controlled by cultivation or by other means. Trees should be planted on the contour to reduce the hazard of erosion.

The moderate permeability of this soil is a limitation for septic tank absorption fields but can generally be overcome by increasing the size of the absorption field. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. Dwellings need to be designed to fit the slope, or the soil can be graded to an acceptable slope. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. 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. Cuts and fills are generally needed to provide a suitable grade for roads and streets.

This soil is in capability units IVe-8 dryland and IVe-3 irrigated, Silty range site, and windbreak suitability group 3.

Nd—Nodaway silt loam, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is on bottom lands that are subject to occasional flooding. The soil formed in alluvium. Areas are long and narrow and range from 5 acres to over 200 acres.

Typically, the surface layer is very dark grayish brown, friable silt loam about 7 inches thick. The underlying material is stratified very dark grayish brown and dark grayish brown silt loam to a depth of 60 inches.

Included with this soil in mapping are small areas of Colo, Judson, and Kennebec soils. The poorly drained Colo soils are in concave areas. The Judson soils are on higher foot slopes and have a subsoil. The Kennebec soils are not as stratified and are at slightly higher positions. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate, and available water capacity is high. Runoff is slow. The seasonal high water table is at a depth of 3 to 5 feet. Organic matter content is moderate, and natural fertility is high.

Nearly all of the acreage of this soil is cultivated. Only small tracts along stream channels are in grass or trees.

This soil is suited to corn, grain sorghum, and soybeans. Row crops can be grown several years in succession if weeds, plant diseases, and insects are controlled. Small grains and alfalfa are damaged by flooding. Frequency of flooding has been reduced by flood control structures upstream. Diversions and dikes can help to protect this soil from overflow. Conservation tillage and returning crop residue maintain the intake of water and organic matter content. The use of fertilizer helps to improve and maintain fertility.

This soil is suited to irrigation. Corn, grain sorghum, alfalfa, and soybeans can be grown in irrigated areas. Erosion on adjacent higher lying soils, which results in accumulation of sediment on this soil, is a hazard under normal rainfall conditions and during applications of irrigation water. The rate of application should be controlled so that it does not exceed the soil's water intake rate.

This soil is suited to grasses for pasture or hay. Pastures generally consist of smooth brome or bluegrass. Proper stocking, timely mowing, rotation grazing, and fertilizing help to keep the grasses vigorous.

This soil is suited to trees and shrubs in windbreaks. Trees survive and grow well if competing vegetation is removed or controlled by cultivation with conventional equipment between the rows and by hand hoeing, rototilling, or using appropriate herbicides in the tree rows. Occasional flooding by runoff from adjacent higher lying soils is a hazard.

This soil is not suitable for septic tank absorption fields or dwelling sites because of flooding and wetness. Other sites should be found. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. Damage to roads and streets 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. Constructing roads on suitable, well compacted fill material above flood level and providing adequate side ditches, culverts, and bridges help to protect roads from flood damage and from wetness caused by the seasonal high water table.

This soil is in capability units IIw-3 dryland and IIw-6 irrigated, Silty Overflow range site, and windbreak suitability group 1.

Nh—Nodaway silt loam, channeled. This deep, moderately well drained soil is on channeled bottom lands that are subject to frequent flooding. The soil formed in alluvium. Areas are dissected by many meandering stream channels and old meander scars and include the adjacent streambanks and breaks. Many of the channels are deeply entrenched and have continuous flow. Areas are long and narrow and range from 10 acres to over 500 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 6 inches thick. The underlying material is stratified, very dark grayish brown silt loam to a depth of 60 inches.

Included with this soil in mapping are small areas of Colo and Judson soils. The poorly drained Colo soils are in concave areas. The Judson soils are on foot slopes. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate, and available water capacity is high. Runoff is slow. The seasonal high water table is at a depth of 3 to 5 feet. Organic matter content is moderate, and natural fertility is high.

Nearly all of the acreage of this soil is in trees and grasses or other vegetation.

Cultivation is generally not practical because of the deeply entrenched channels. A few areas are farmed with adjacent soils.

This soil is suited to range. Growth of the more desirable grasses is restricted in some areas by the tree canopy. Overgrazing by livestock and deposition of silt reduce the protective cover and cause deterioration of the native vegetation. Proper grazing use, timely deferment from grazing, and a planned grazing system help to maintain or improve range condition.

This soil is generally not suited to trees and shrubs in windbreaks because of the frequent flooding and the meandering streams. Trees and shrubs can be hand planted or are growing naturally in higher areas.

Areas that support mostly trees, woody shrubs, and annual weeds can provide good cover and habitat for many kinds of wildlife. Fresh water is available in the stream channel most of the year. The grain crops in nearby areas provide additional food for wildlife.

This soil is not suitable for septic tank absorption fields or dwelling sites because of flooding and wetness. Other sites should be found. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. Damage to roads 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. Constructing roads on suitable, well compacted fill material above flood level and providing adequate side ditches, culverts, and bridges help to protect roads from flood damage and from wetness caused by the seasonal high water table.

This soil is in capability unit VIw-7 dryland, Silty Overflow range site, and windbreak suitability group 10.

On—Onawa silty clay, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on bottom lands along major rivers. The soil formed in alluvium. This soil is subject to occasional flooding, but some areas are protected by dikes. Individual areas range from 10 acres to over 100 acres in size.

Typically, the surface layer is very dark grayish brown, firm silty clay about 8 inches thick. The upper 19 inches of the underlying material is stratified very dark gray and very dark grayish brown silty clay and clay. The lower part of the underlying material is stratified, mottled, dark grayish brown silty clay loam, silt loam, and very fine sandy loam to a depth of 60 inches. In some places, sand is below a depth of 24 inches. In a few places the clayey layer is less than 18 inches thick.

Included with this soil in mapping are small areas of poorly drained Albaton soils at slightly lower positions and moderately well drained Haynie soils at slightly higher positions. Included areas make up about 5 to 15 percent of the unit.

Permeability is slow in the upper part and moderate in the lower part. Available water capacity is high. Runoff is slow. A seasonal high water table is at a depth of about 3 to 4 feet. This soil dries slowly, and planting is often delayed. Tilth is poor. Organic matter content is moderate, and natural fertility is high. The shrink-swell potential is high in the upper part.

Most of the acreage of this soil is cultivated. A few areas are in grass or trees.

This soil is suited to corn, soybeans, and sorghum. Row crops can be grown several years in succession if weeds, plant diseases, and insects are controlled. Proper placement of rows, land leveling, and surface ditching improve drainage. If there are suitable outlets, drainage tile can be used to intercept water. This soil dries slowly in spring and during rainy periods; cultivation, planting, and harvesting are commonly delayed. Returning crop residue to the soil helps to maintain organic matter content and soil structure (fig. 8). Application of fertilizer helps to maintain fertility.

Under irrigation, this soil is suited to row crops, such as corn, grain sorghum, and soybeans. Wetness is the main problem. Land leveling can improve surface drainage and increase irrigation efficiency. Gravity and sprinkler irrigation systems are suitable.

This soil is suited to grasses for pasture or hay. Pasture commonly consists of smooth brome or other introduced grasses. Most cool-season grasses do well, but commercial fertilizer is needed. Overgrazing or grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking and rotation grazing help to keep the grasses in good condition.

This soil is suited to trees and shrubs in windbreaks. Survival and growth of species that tolerate occasional wetness are good. Weeds and grasses can be controlled by cultivating between the rows with conventional equipment and by applying appropriate herbicides, hand hoeing, or rototilling in the tree rows. Establishing seedlings can be a problem during wet periods. A light cultivation and supplemental watering can be used to close the cracks that form during dry periods.

This soil is not suitable for dwelling sites or septic tank absorption fields because of flooding and wetness. Other sites should be found. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. 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 to roads 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 helps to provide the needed surface drainage.

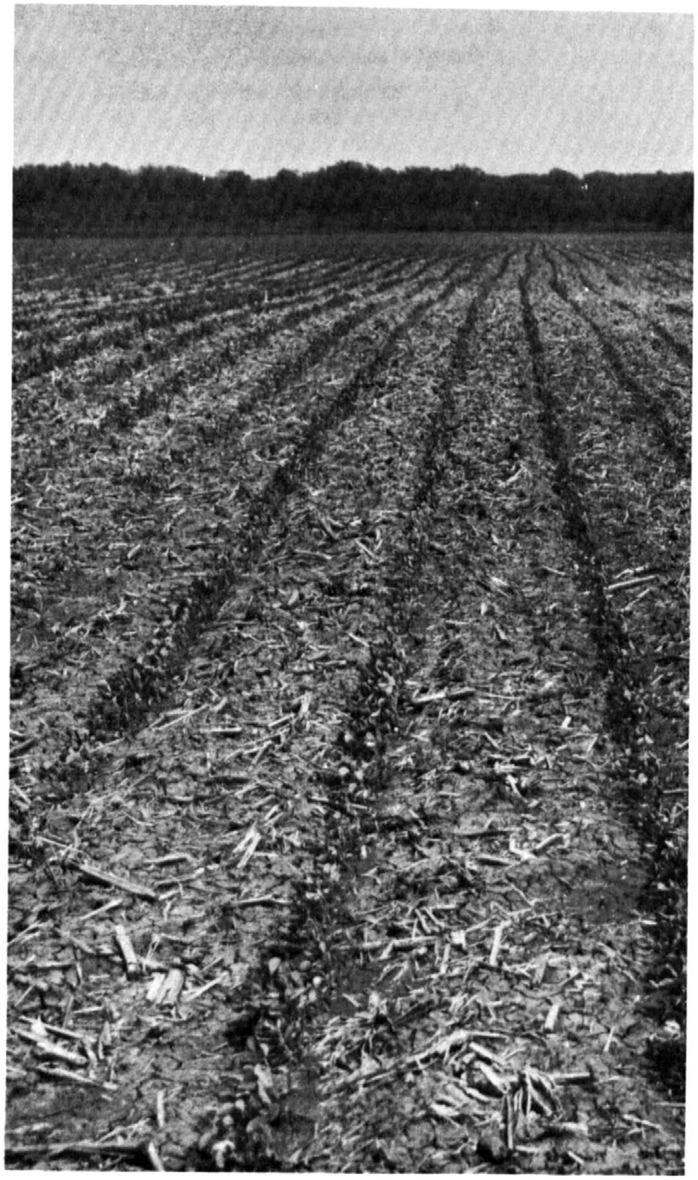

Figure 8.—Conservation tillage on Onawa silty clay, 0 to 2 percent slopes. Crop is soybeans.

This soil is in capability units IIw-1 dryland and IIw-1 irrigated, Clayey Overflow range site, and windreak suitability group 2S.

PaD2—Pawnee clay loam, 6 to 11 percent slopes, eroded. This deep, strongly sloping, moderately well drained soil is on upland side slopes. The soil formed in glacial till. Pebbles and cobbles are on the surface in some places. Individual areas range from 3 to 30 acres in size. Erosion has removed much of the original dark surface layer over most of the area.

Typically, the surface layer is very dark grayish brown, friable clay loam about 6 inches thick. The subsoil is firm clay about 36 inches thick; the upper part is dark brown, the middle part is olive brown, and the lower part is light olive brown. The underlying material is light olive brown and is clay in the upper part and clay loam in the lower part to a depth of 60 inches. Mottles are present in the lower part of the subsoil and below. In some places, the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Colo, Mayberry, Nodaway, Sharpsburg, and Wymore soils. Colo and Nodaway soils are on the bottom of the narrow drainageways. Colo soils are somewhat poorly drained and poorly drained. Nodaway soils are stratified. Mayberry soils are reddish brown. Sharpsburg and Wymore soils are at higher positions and formed in loess. Included areas make up about 15 percent of the unit.

Permeability is slow, and available water capacity is moderate. The subsoil releases moisture slowly during dry periods. Runoff is rapid. A perched seasonal high water table is at a depth of 1 to 3 feet in spring of some years. Organic matter content is moderately low, and natural fertility is medium. Tilth is poor; the moderately fine textured surface layer is difficult to till. The clayey subsoil somewhat limits root penetration and restricts water movement. The shrink-swell potential is high.

Most of the acreage of this soil is cultivated. Some areas are in grasses and are used for grazing or hay.

This soil is poorly suited to crops. Small grains, legumes, and grain sorghum are commonly grown. The main concern in management is controlling runoff and erosion and maintaining a medium fertility level. The cropping system should consist mainly of close-growing crops, such as small grains and legumes. Row crops should be limited. Terraces, grassed waterways, and contour farming help to control runoff and erosion. Organic matter content and tilth can be improved by returning crop residue to the soil.

This soil is suited to grasses for pasture or hay. A good cover of grasses helps to control erosion. Soil loss can occur and undesirable plants can grow if management is poor. Fertilizer should be applied according to soil tests. Proper stocking, timely mowing, and rotation grazing help to keep the grass and soil in good condition.

This soil is poorly suited to trees and shrubs in windbreaks. Special care is needed if young trees are to grow well. Applying additional water during dry periods promotes growth. This soil absorbs and releases moisture too slowly to sustain good tree growth. Control of weeds and competing vegetation conserves moisture. Windbreaks should be planted on the contour to reduce runoff.

This soil is not suitable for septic tank absorption fields because of slow permeability and wetness. Other sites should be found. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. Constructing dwellings on raised, well compacted fill material avoids wetness caused by the perched seasonal high water table. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. Damage to roads 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. Mixing the base material for roads and streets with additives, such as hydrated lime, helps to prevent shrinking and swelling.

This soil is in capability unit IVe-2 dryland, Clayey range site, and windbreak suitability group 4C.

Pg—Pits and dumps. These areas consist of open excavations and mounds of sand, gravel, and overburden associated with sand and gravel mining. The sand and gravel are stockpiled for use in construction. Areas are mostly on bottom lands. Low areas may be subject to occasional flooding in spring. Most of the pits contain water. Areas range from 30 acres to over 200 acres in size.

Typical material in these areas is a mixture of stratified fine, medium, and coarse sand and gravelly sand. There are no distinct soil horizons because the soils have been disturbed by mining operations.

Included in mapping are small areas of Sarpy soils, which have a thin surface layer. Included areas make up about 10 percent of the map unit.

Permeability is rapid or very rapid, and available water capacity is very low. Runoff is very slow. Organic matter content is very low, and natural fertility is low. The level of the water in the pits generally is 5 to 10 feet below the land surface.

These areas are generally not suited to agricultural uses. Where these areas are no longer mined, sparse vegetation gradually becomes established.

Cottonwood and willow are best as either individual or scattered plantings. Individually hand-planted trees and shrubs need special care to survive. Newly planted trees and shrubs need supplemental watering to keep the small plants alive, and they need protection from blowing sand. Establishing grass, shrubs, and trees is difficult.

These areas are suited to recreational use. Roads can be built to lakes and picnic areas. The fine sand left from mining operations makes ideal beaches. The areas can be shaped and leveled to provide sites for swimming, camping, and cottages. Other possible activities include fishing, boating, water skiing, and hiking.

The hazard of flooding should be considered if this unit is used as a site for buildings or sanitary facilities. In some areas, summer cottages have been built around the shoreline of the pits. Because of its rapid permeability, this material does not adequately filter effluent from waste disposal systems. Seepage from septic tank absorption fields can contaminate the ground water. Therefore other sites should be found. Sides of foundations and shallow excavations can be shored to prevent sloughing or caving in of loose sand.

This map unit is in capability unit VIIIs-4 dryland and windbreak suitability group 10.

Ph—Pits, Quarries. These areas consist of open excavations from which soil and underlying limestone have been removed. Also included are soil and limestone stockpiled for use in construction and road surfacing and as agricultural lime. Lower areas are ponded in places. The terrain ranges from bare level areas to surrounding bare vertical walls. Areas range from 5 acres to over 200 acres in size.

Typical material in these areas is a mixture of silty clay loam, silt loam, clay loam, and various size fragments of limestone, sandstone, and shale. The stockpiled soil material is from soils that have been disturbed by excavation.

Included in mapping are areas where the limestone is processed for use and where the limestone is no longer mined.

Most of the acreage is used in the commercial production of limestone (fig. 9). The areas no longer mined are used as wildlife habitat.

These areas are not suited to agricultural use. Unless reclaimed, these areas have limited use. Grading and land filling are generally required to reestablish vegetation. These areas are not suitable for septic tank absorption fields or dwelling sites because of the shallow depth to rock, steep slopes, and commercial mining operations.

This map unit is in capability unit VIIIs-8 dryland and windbreak suitability group 10.

Sa—Sarpy loamy fine sand, frequently flooded. This deep, very gently sloping or undulating, excessively drained soil is on bottom lands adjacent to major rivers. The soil formed in alluvium. Slope ranges from 0 to 3 percent. This soil is frequently flooded. Areas are long and narrow and range from 5 to 30 acres in size.

Typically, the surface layer is very dark grayish brown loamy fine sand about 6 inches thick. The underlying material is stratified very dark grayish brown and dark grayish brown fine sand, loamy fine sand, and very fine sandy loam to a depth of 60 inches. In some places, the profile has thin strata of silt loam and silty clay loam.

Included with this soil in mapping are small areas of poorly drained Albaton soils, somewhat poorly drained Onawa soils, and moderately well drained Haynie soils. Albaton and Onawa soils generally are in the depressional areas. Included areas make up about 20 percent of the unit.

Permeability is rapid, and available water capacity is low. Runoff is slow. Organic matter content and natural

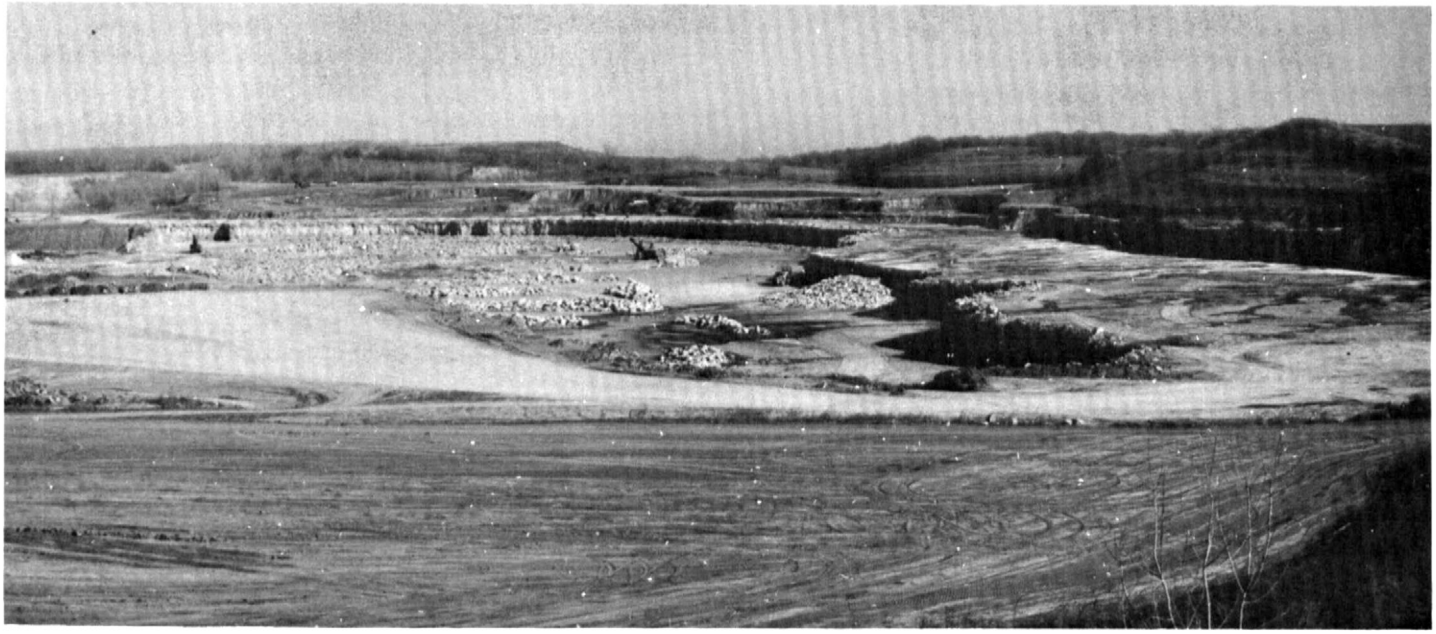

Figure 9.—Limestone quarry.

fertility are low. The soil dries rapidly, and unless it has a plant cover, it is subject to wind erosion.

Most of the acreage of this soil is in cottonwood, willows, and grass. It is mainly used as wildlife habitat. A few areas are grazed.

This soil generally is not suited to common crops because of the combination of frequent flooding, undulating surface, and droughtiness.

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

This soil is generally not suited to trees and shrubs in windbreaks because of the frequent flooding and the meandering channels. Trees and shrubs can be hand planted or are growing naturally in higher areas.

This soil is not suitable for dwelling sites or septic tank absorption fields because of flooding. This soil readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent, which may pollute the ground water. 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 unit VIw-7 dryland and windbreak suitability group 10.

SbB—Sarpy-Haynie complex, 0 to 3 percent slopes. These deep, nearly level and very gently sloping, excessively drained and moderately well drained soils are on bottom lands along major rivers. These soils formed in alluvium. They are subject to occasional flooding, but some areas are protected by dikes. Individual areas range in size from 10 acres to over 200 acres. This complex is 40 to 60 percent Sarpy soil and 30 to 55 percent Haynie soil. Commonly, the excessively drained Sarpy soil is in the slightly higher, gently undulating areas, and the moderately well drained Haynie soil is in the more nearly level areas.

Typically, the Sarpy soil has a surface layer of very dark grayish brown, very friable loamy fine sand about 6 inches thick. The underlying material is stratified dark brown, dark grayish brown, and brown loamy fine sand and fine sand to a depth of 60 inches. In some places, the lower part of the profile is silty clay loam.

Typically, the Haynie soil has a surface layer of very dark grayish brown, very friable very fine sandy loam about 6 inches thick. The underlying material, to a depth of 60 inches, is stratified dark brown, dark grayish brown, and brown silt loam, very fine sandy loam, fine sandy loam, and loamy fine sand and is mottled.

Included with these soils in mapping are small areas of somewhat poorly drained Onawa soils in slightly lower positions. These areas make up about 10 percent of the unit.

Permeability is rapid in the Sarpy soil and moderate in the Haynie soil. Available water capacity is low in the Sarpy soil and high in the Haynie soil. Runoff is slow on both soils. The Sarpy soil dries rapidly and can be easily worked in most conditions. The Haynie soil dries readily after rains and is easy to work. Organic matter content and natural fertility are low in the Sarpy soil. In the Haynie soil organic matter content is moderate and natural fertility is high.

Most of the acreage of this complex is cultivated. A few areas are in cottonwood and willows.

This complex is poorly suited to cultivated crops because of the low available water capacity and low fertility of the Sarpy soil. The occasional flooding can be controlled by diversions and dikes on the local flood plain. Conservation tillage practices that leave crop residue on the surface help to conserve moisture, control wind erosion, and increase the organic matter content. Applying fertilizer helps to maintain fertility. Close-growing crops are more suitable than row crops because most of their growth is in spring, when rainfall is greatest.

Under irrigation, these soils are better suited to close-growing crops, such as alfalfa, introduced grasses, and small grain. Sprinkler irrigation is the only kind of system suited to the soils. Wind erosion and low moisture retention are the main problems. The application rate of water can be high because the soils absorb the water rapidly, but applications must be frequent because of low moisture retention. Conservation tillage reduces wind erosion.

These soils are suited to grasses. Some areas are used for pasture or hay. Pastures commonly consist of smooth brome or other introduced grasses. Using legumes or commercial fertilizer will increase production. Overgrazing can easily result in wind erosion. Proper stocking and rotation grazing help to keep the grasses in good condition.

These soils are suited to trees and shrubs in windbreaks. Survival and growth of adapted species are fair on the Sarpy soil and good on the Haynie soil. Wind erosion and competition for moisture are concerns in management. Erosion can be controlled by maintaining strips of sod or a cover crop between the tree rows. Cultivation generally should be restricted to the tree rows. Irrigation can provide supplemental moisture during periods of low rainfall.

These soils are not suitable for dwelling sites or septic tank absorption fields because of flooding. Other sites should be found. In areas protected by dikes, these soils are generally suitable for dwellings. The Sarpy soil readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent, which may pollute the ground water. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. Damage to roads and streets by frost action can be reduced by providing good surface drainage. Crowning the road by grading and constructing roads on suitable, well compacted fill material above flood level and providing adequate side ditches and culverts help to provide the needed surface drainage and protect roads from flood damage.

These soils are in capability unit IVs-7 dryland. The Sarpy soil is in Sandy Overflow range site and windbreak suitability group 5. The Haynie soil is in Silty Lowland range site and windbreak suitability group 1L.

Sh—Sharpsburg silty clay loam, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is on broad divides on the uplands. The soil formed in loess. Individual areas range from 10 acres to over 600 acres in size.

Typically, the surface layer is very dark brown, friable silty clay loam about 6 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 6 inches thick. The subsoil is friable silty clay loam about 32 inches thick; it is dark brown in the upper part, dark yellowish brown in the middle part, and yellowish brown in the lower part. The underlying material is yellowish brown, mottled silty clay loam to a depth of 60 inches. In some places, the surface layer is thicker.

Included with this soil in mapping are small areas of Fillmore soils. Fillmore soils are poorly drained and are in slight depressions. Included areas make up about 5 percent of the unit.

Permeability is moderately slow, and available water capacity is high. Moisture is released readily to plants. Runoff is medium. Organic matter content is moderate, and natural fertility is high. This soil generally has good tilth. The shrink-swell potential is high in the subsoil.

Most of the acreage of this soil is cultivated.

This soil is suited to corn, grain sorghum, wheat, soybeans, and alfalfa. Maintaining the content of organic matter and keeping fertility high are main concerns in management. This soil can be farmed intensively without risk of damage from erosion. Row crops can be grown several years in succession. Conservation tillage practices that leave crop residue on the soil surface help to conserve soil moisture. Returning crop residue to the soil helps to maintain and improve the organic matter content and increases the intake of water. The use of fertilizer or legumes helps to maintain fertility.

This soil is suited to gravity and sprinkler irrigation. Corn, grain sorghum, alfalfa, and soybeans can be grown in irrigated areas. Some land leveling is generally needed before water can be applied by a gravity system.

This soil is suited to grasses and legumes for pasture and hay. Smooth brome, orchardgrass, tall fescue, and reed canarygrass grow well. A legume in the grass mixture increases forage production. Fertilizer should be applied according to soil tests. Proper stocking, timely mowing, and rotation grazing help to keep the grasses vigorous.

This soil is suited to trees and shrubs in windbreaks. Survival of adapted species is good, and growth is fair. Competition for moisture from weeds and grasses can be eliminated by cultivating between the rows and by hand hoeing, rototilling, or using herbicides in the row.

The moderately slow permeability of this soil is a limitation for septic tank absorption fields but can generally be overcome by increasing the size of the absorption field. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. 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 soil is in capability units I-1 dryland and I-3 irrigated, Silty range site, and windbreak suitability group 3.

ShC—Sharpsburg silty clay loam, 2 to 5 percent slopes. This deep, gently sloping, moderately well drained soil is on wide ridgetops and upper parts of side slopes on the uplands. The soil formed in loess. Individual areas range from 5 acres to over 100 acres in size.

Typically, the surface layer is very dark brown, friable silty clay loam about 6 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 8 inches thick. The subsoil is about 31 inches thick. The upper part of the subsoil is dark brown, friable silty clay loam and silty clay; the middle part is dark yellowish brown, friable silty clay loam; and the lower part is yellowish brown, friable silty clay loam. The underlying material is yellowish brown and grayish brown silty clay loam to a depth of 60 inches. In some places, the surface layer is thinner and lighter colored.

Included with this soil in mapping are small areas of Judson and Nodaway soils along drainageways. Judson soils have a thicker surface soil. Nodaway soils are subject to flooding. Included areas make up about 5 percent of the unit.

Permeability is moderately slow, and available water capacity is high. Moisture is released readily to plants. Runoff is medium. Organic matter content is moderate, and natural fertility is high. Tilth is generally good, and the soil is easily tilled through a fairly wide range of moisture content. The shrink-swell potential is high in the subsoil.

Most of the acreage of this soil is cultivated.

This soil is suited to corn, grain sorghum, soybeans, wheat, and alfalfa. Row crops can be grown several years in succession. Water erosion and runoff are the main concerns in management. Terraces, grassed waterways, and contour farming help to control erosion and runoff. Returning crop residue to the soil increases intake of water and helps to maintain organic matter content. The use of fertilizer or legumes helps to maintain fertility.

This soil is suited to sprinkler irrigation. Corn, grain sorghum, alfalfa, and soybeans can be grown in irrigated areas. Irrigation water should be applied at the proper time and in proper amounts. Conservation tillage practices that keep crop residue on the surface help to control erosion and runoff.

This soil is suited to grasses and legumes for pasture and hay. Smooth brome, orchardgrass, tall fescue, and reed canarygrass grow well. A legume can be included in the planting to increase forage production. Fertilizer should be applied according to soil tests. Proper stocking, timely mowing, and rotation grazing help to keep the grasses vigorous.

This soil is suited to trees and shrubs in windbreaks. Survival of adapted species is good, and growth is fair. Competition for moisture from weeds and grasses can be eliminated by cultivating between the rows and by hand hoeing, rototilling, or using appropriate herbicides in the row. Planting trees and shrubs on the contour reduces erosion.

The moderately slow permeability of this soil is a limitation for septic tank absorption fields but can generally be overcome by increasing the size of the absorption field. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. The surface pavement and the base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. 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 soil is in capability units IIe-1 dryland and IIIe-3 irrigated, Silty range site, and windbreak suitability group 3.

ShC2—Sharpsburg silty clay loam, 2 to 5 percent slopes, eroded. This deep, gently sloping, moderately well drained soil is on narrow ridgetops and upland side slopes. The soil formed in loess. Rills and small gullies are common after heavy rains. Individual areas range from 10 acres to over 1,000 acres in size. Erosion has removed much of the original dark surface soil over most of the area.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 7 inches thick. The subsurface layer is dark brown, friable silty clay loam about 3 inches thick. The subsoil is friable silty clay loam about 35 inches thick; the upper part is dark yellowish brown, and the lower part is yellowish brown. The underlying material is light yellowish brown silty clay loam to a depth of 60 inches. The lower part of the subsoil and the underlying material are mottled.

Included with this soil in mapping are small areas of Judson and Nodaway soils along drainageways. Judson soils have a thicker surface soil. Nodaway soils are occasionally flooded. Included areas make up about 10 percent of the unit.

Permeability is moderately slow, and available water capacity is high. This soil releases moisture readily to plants. Runoff is medium. Organic matter content is moderately low, and natural fertility is high. Tilth is generally good, and the soil is easily tilled through a fairly wide range of moisture content. The shrink-swell potential is high in the subsoil.

Most of the acreage of this soil is cultivated.

This soil is suited to corn, grain sorghum, soybeans, wheat, and alfalfa. Water erosion is the main problem. Terraces, grassed waterways, and contour farming help to control erosion and runoff. Returning crop residue to the soil helps to maintain organic matter content. The use of fertilizer or legumes helps to maintain fertility.

This soil is suited to sprinkler irrigation. Corn, grain sorghum, alfalfa, and soybeans can be grown in irrigated areas. Erosion may increase because of application of irrigation water. Water should be applied at a rate not higher than the intake rate of the soil. Conservation tillage practices that keep crop residue on the surface help to control erosion and runoff.

This soil is suited to grasses and legumes for pasture and hay. Smooth brome is commonly grown, but orchardgrass, tall fescue, and reed canarygrass also grow well. A legume is desirable in the planting. Fertilizer should be applied according to soil tests. Proper stocking, timely mowing, and rotation grazing help to keep the grasses vigorous.

This soil is suited to trees and shrubs in windbreaks. Survival of adapted species is good, and growth is fair. Competition for moisture from weeds and grasses can be eliminated by cultivating between the rows and by hand hoeing, rototilling, or using appropriate herbicides in the row. Planting trees and shrubs on the contour reduces erosion.

The moderately slow permeability of this soil is a limitation for septic tank absorption fields but can generally be overcome by increasing the size of the absorption fields. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. 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 soil is in capability units IIe-1 dryland and IIIe-3 irrigated, Silty range site, and windbreak suitability group 3.

ShD—Sharpsburg silty clay loam, 5 to 9 percent slopes. This deep, strongly sloping, moderately well drained soil is on upland side slopes. The soil formed in loess. Individual areas range from 5 to 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 6 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 8 inches thick. The subsoil is friable silty clay loam about 34 inches thick; it is dark brown in the upper part and dark yellowish brown in the lower part. The underlying material is yellowish brown silty clay loam to a depth of 60 inches. In some places, the surface soil is thinner and lighter in color.

Included with this soil in mapping are small areas of Colo, Judson, and Nodaway soils. Colo and Nodaway soils are on bottom lands. Colo soils are poorly drained and somewhat poorly drained. Nodaway soils are stratified. Judson soils are on foot slopes and have a thicker surface soil. Included areas make up less than 10 percent of the unit.

Permeability is moderately slow, and available water capacity is high. Moisture is readily available to plants. Runoff is rapid. Organic matter content is moderate, and natural fertility is high. This soil is easy to till. The shrink-swell potential is high in the subsoil.

Most of the acreage of this soil is cultivated.

This soil is suited to corn, grain sorghum, soybeans, wheat, and alfalfa. Limiting consecutive row crops and growing close-sown crops, such as small grains and alfalfa, help to control erosion and conserve water. Water erosion and runoff are the main concerns in management. Terraces, grassed waterways, and contour farming help to control erosion and runoff. Returning crop residue to the soil helps to maintain organic matter content and increases the intake of water. The use of fertilizer or legumes helps to maintain fertility.

This soil is poorly suited to sprinkler irrigation, but corn, grain sorghum, and alfalfa can be grown in irrigated areas. Erosion is the main hazard. Irrigation water should be applied at the proper time and in proper amounts. Conservation tillage practices that keep crop residue on the surface help to control erosion and runoff. Terraces, grassed waterways, and contour farming help to control erosion.

This soil is suited to grasses and legumes for pasture or hay. Smooth brome is commonly grown. A legume is desirable in the planting system. Permanent grass is effective in controlling erosion. Fertilizer should be applied according to soil tests. Proper stocking, timely mowing, and rotation grazing help to keep the grass and soil in vigorous condition.

This soil is suited to trees and shrubs in windbreaks. Survival of adapted species is good, and growth is fair. Competition for moisture from weeds and grasses can be eliminated by cultivating between the rows and by hand hoeing, rototilling, or using appropriate herbicides in the row. Planting trees on the contour helps to prevent erosion. Terraces are also helpful.

The moderately slow permeability of this soil is a limitation for septic tank absorption fields but can generally be overcome by increasing the size of the absorption field. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. 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 soil is in capability units IIIe-1 dryland and IVe-3 irrigated, Silty range site, and windbreak suitability group 3.

ShD2—Sharpsburg silty clay loam, 5 to 9 percent slopes, eroded. This deep, strongly sloping, moderately well drained soil is on side slopes on the uplands. The soil formed in loess. Individual areas range from 5 acres to over 400 acres in size. Erosion has removed much of the original dark surface soil over most of the area.

Typically, the surface layer is dark brown, friable silty clay loam about 6 inches thick. The subsoil is friable silty clay loam about 24 inches thick; it is dark yellowish brown in the upper part and yellowish brown in the lower part. The underlying material is yellowish brown silty clay loam to a depth of 60 inches.

Included with this soil in mapping are small areas of Colo, Judson, Nodaway, and Wymore soils. Colo and Nodaway soils are on bottom lands. Colo soils are poorly drained and somewhat poorly drained. Nodaway soils are occasionally flooded. Judson soils are on foot slopes and have a thicker surface soil. Wymore soils have more clay in the subsoil. Included areas make up about 15 percent of the unit.

Permeability is moderately slow, and available water capacity is high. This soil releases moisture readily to plants. Runoff is rapid. Organic matter content is moderately low, and natural fertility is medium. Tilth is fair. The shrink-swell potential is high in the subsoil.

Most of the acreage of this soil is cultivated.

This soil is suited to corn, grain sorghum, soybeans, wheat, and alfalfa. Limiting consecutive row crops and growing close-sown crops, such as small grains and alfalfa, help to control erosion and conserve water. Water erosion is the main problem. Terraces, grassed waterways, and contour farming help to control erosion and runoff (fig. 10). Returning crop residue to the soil helps to maintain organic matter content and increases the intake of water. The use of fertilizer or legumes helps to maintain fertility.

Figure 10.—Terraces, grassed waterways, and contour farming on Sharpsburg silty clay loam, 5 to 9 percent slopes, eroded.

This soil is poorly suited to sprinkler irrigation, but corn, grain sorghum, and alfalfa can be grown in irrigated areas. Erosion is the main hazard. Irrigation water should be applied at the proper time and in proper amounts. Conservation tillage practices that keep crop residue on the surface help to control erosion and runoff. Terraces, grassed waterways, and contour farming also help to control erosion.

This soil is suited to grasses and legumes for pasture or hay. Smooth brome is commonly grown. A legume is desirable in the planting system. Permanent grass is effective in controlling erosion. Fertilizer should be applied according to soil tests. Rill erosion is a hazard on overgrazed pasture. Proper stocking, timely mowing, and rotation grazing help to keep the grass and soil in good condition.

This soil is suited to trees and shrubs in windbreaks. Survival of adapted species is good, and growth is fair. Competition for moisture from weeds and grasses can be eliminated by cultivating between the rows and by hand hoeing, rototilling, or using appropriate herbicides in the row. Planting trees on the contour helps to prevent erosion. Terraces are also helpful.

The moderately slow permeability of this soil is a limitation for septic tank absorption fields but can generally be overcome by increasing the size of the absorption field. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. 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 soil is in capability units IIIe-8 dryland and IVe-3 irrigated, Silty range site, and windbreak suitability group 3.

ShE2—Sharpsburg silty clay loam, 9 to 15 percent slopes, eroded. This deep, moderately steep, moderately well drained soil is on upland side slopes. The soil formed in loess. Individual areas range from 5 to 100 acres in size. Erosion has removed much of the original dark surface soil over most of the area.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 5 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 3 inches thick. The subsoil is friable silty clay loam about 18 inches thick; it is brown in the upper part and dark yellowish brown in the lower part. The underlying material is mottled silty clay loam to a depth of 60 inches; it is yellowish brown in the upper part and grayish brown in the lower part.

Included with this soil in mapping are small areas of Judson and Nodaway soils. Judson soils are on foot slopes and have a thicker surface soil. Nodaway soils are along drainageways and are occasionally flooded. Included areas make up about 10 percent of the unit.

Permeability is moderately slow, and available water capacity is high. Moisture is readily available to plants. Runoff is rapid. Organic matter content is moderately low, and natural fertility is medium. Tilth is fair. The shrink-swell potential is high in the subsoil.

Most of the acreage of this soil is cultivated. Some areas are in grass and trees and are used for grazing.

This soil is poorly suited to corn, grain sorghum, soybeans, wheat, and alfalfa. It is best suited to close-growing crops, but row crops can be grown if a high level of management adequately controls erosion. Water erosion is the main problem. Terraces are a good method to control erosion and conserve surface water. Returning crop residue to the soil helps to maintain and improve the organic matter content. Contour farming and grassed waterways help to control erosion.

This soil is suited to grasses and legumes for pasture and hay. Pastures commonly consist of smooth brome or a mixture of smooth brome and alfalfa. This use is effective in controlling erosion. Gully and rill erosion can be hazards in overgrazed pasture. Proper stocking, timely mowing, rotation grazing, and fertilizing help to keep the grasses and soil in good condition.

This soil is suited to trees and shrubs in windbreaks. Survival of adapted species is good, and growth is fair. Competition for moisture from weeds and grasses can be eliminated by cultivating between the rows and by hand hoeing, rototilling, or using apropriate herbicides in the row. Contour planting and terraces help to prevent erosion and excessive runoff. Growth may be somewhat slower in the steepest areas.

The moderately slow permeability of this soil is a limitation for septic tank absorption fields but can generally be overcome by increasing the size of the absorption field. For proper operation of septic tank absorption fields, the land must be reshaped and the lines laid on the contour. Foundations for dwellings need to be strengthened and backfilled with coarser material to prevent damage by shrinking and swelling of the soil. Dwellings need to be designed to fit the slope, or the soil can be graded to an acceptable slope. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. 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.

The soil is in capability unit IVe-8 dryland, Silty range site, and windbreak suitability group 3.

Sk—Sharpsburg silty clay loam, terrace, 0 to 1 percent slopes. This deep, nearly level, moderately well drained soil is on stream terraces. The soil formed in loess. Individual areas range from 5 to 600 acres in size.

Typically, the surface layer is very dark brown, friable silty clay loam about 7 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 10 inches thick. The subsoil is friable silty clay loam about 35 inches thick; the upper part is dark brown, the middle part is dark yellowish brown, and the lower part is yellowish brown. The underlying material is yellowish brown silty clay loam to a depth of 60 inches. In some places, it has a few small lime concretions below a depth of 50 inches. In some places, the underlying material is slightly affected by soluble salts. Stratified alluvial material is at a depth of 10 to 20 feet.

Included with this soil in mapping are a few small areas of poorly drained Fillmore soils in small depressions. These areas make up about 5 percent of the unit.

Permeability is moderately slow, and available water capacity is high. This soil readily releases moisture to plants. Runoff is slow. The organic matter content is moderate, and natural fertility is high. This soil generally has good tilth. The shrink-swell potential is high in the subsoil. The ground water is 6 to 12 feet below the surface in most areas.

Most of the acreage of this soil is cultivated.

This soil is suited to corn, grain sorghum, wheat, soybeans, and alfalfa. Established alfalfa stands benefit from the ground water in most areas. Maintaining the organic matter content and keeping fertility high are the main concerns in management. This soil can be farmed intensively without risk of damage from erosion. Row crops can be grown several years in succession if weeds, insects, and plant diseases are controlled. Conservation tillage practices that leave crop residue on the soil surface help to conserve soil moisture. Returning crop residue to the soil helps to maintain and improve the organic matter content and increases intake of water. The use of fertilizer or legumes helps to maintain fertility.

Under irrigation, this soil is suited to corn, alfalfa, grain sorghum, and soybeans. Water can be applied by gravity or sprinkler systems. Applications of proper amounts of water should be timely. Applying barnyard manure and crop residue improves infiltration of water on areas that have been disturbed during land leveling operations.

This soil is well suited to tame pasture. Smooth brome, orchardgrass, tall fescue, and reed canarygrass grow well. A legume in the planting increases forage production. Fertilizer should be applied according to soil tests. Deep-rooted plants benefit from the ground water. Proper stocking, timely mowing, and rotation grazing help to keep the grass in good condition.

This soil is suited to trees and shrubs in windbreaks. Survival of adapted species is good, and growth is fair. Competition for moisture from weeds and grasses can be eliminated by cultivating between the rows and by hand hoeing, rototilling, or using appropriate herbicides in the row.

The moderately slow permeability of this soil is a limitation for septic tank absorption fields but can generally be overcome by increasing the size of the absorption field. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. 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 soil is in capability units I-1 dryland and I-3 irrigated, Silty range site, and windbreak suitability group 3.

SkB—Sharpsburg silty clay loam, terrace, 1 to 3 percent slopes. This deep, very gently sloping, moderately well drained soil is on stream terraces. The soil formed in loess. Individual areas range from 5 to 200 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 6 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 7 inches thick. The subsoil is friable silty clay loam about 33 inches thick; the upper part is dark brown, and the lower part is dark yellowish brown. The underlying material is yellowish brown silty clay loam to a depth of 60 inches. Some areas have less clay in the subsoil. Stratified alluvial material is at a depth of 10 to 20 feet.

Included with this soil in mapping are some small saline-alkali areas. These areas make up about 5 percent of the unit.

Permeability is moderately slow, and available water capacity is high. This soil readily releases moisture to plants. Runoff is medium. Organic matter content is moderate, and natural fertility is high. This soil generally has good tilth. The shrink-swell potential is high in the subsoil. The ground water is usually 6 to 12 feet below the surface in most areas.

Most of the acreage of this soil is cultivated.

This soil is suited to corn, grain sorghum, wheat, soybeans, and alfalfa. Established alfalfa stands benefit from the ground water in most areas. Controlling water erosion is the main concern in management. Terraces, grassed waterways, and farming on the contour help to control runoff and erosion. Returning crop residue to the soil helps to maintain and improve the organic matter content. The use of fertilizer or legumes in the cropping sequence helps to maintain fertility.

Under irrigation, this soil is suited to corn, grain sorghum, and soybeans. Sprinkler irrigation is better for this soil. The slope makes erosion by irrigation water difficult to control. The rate of water application should be carefully controlled to not exceed the water intake rate of the soil.

This soil is well suited to tame pasture. Smooth brome, orchardgrass, tall fescue, and reed canarygrass grow well. A legume in the planting increases forage production. Fertilizer should be applied according to soil tests. Deep-rooted plants benefit from the ground water. Proper stocking, timely mowing, and rotation grazing help to keep the grasses vigorous.

This soil is suited to trees and shrubs in windbreaks. Growth of adapted species is good. Competition for moisture from weeds and grasses can be eliminated by cultivating between the rows and by hand hoeing, rototilling, or using appropriate herbicides in the row. Planting trees and shrubs on the contour helps to reduce erosion.

The moderately slow permeability of this soil is a limitation for septic tank absorption fields but can generally be overcome by increasing the size of the absorption field. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. 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 soil is in capability units IIe-1 dryland and IIIe-3 irrigated, Silty range site, and windbreak suitability group 3.

SmB—Sharpsburg Variant silty clay loam, 1 to 4 percent slopes. This deep, very gently sloping, moderately well drained, saline-alkali soil is on stream terraces and lower side slopes on uplands. The soil formed in loess. The vegetation has a patchy appearance. Growth is fair in areas less affected by salt and alkali, but plants are very stunted on the more severely affected areas. Individual areas of this unit are irregular in shape and range from 3 to 20 acres in size.

Typically, the surface layer is very dark brown, friable silty clay loam about 4 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 6 inches thick. The subsoil is firm silty clay about 31 inches thick; the upper part is dark brown, and the lower part is yellowish brown. The underlying material is yellowish brown silty clay to a depth of 60 inches.

Included with this soil in mapping are small areas of soils that are not affected by soluble salts. Included areas make up about 10 percent of the unit.

Permeability is slow, and available water capacity is moderate. Runoff is medium. Organic matter content is moderately low. This soil is slightly to moderately affected by soluble salts. Even in the more productive areas of this soil, exchangeable sodium retards plant growth. Reaction in the subsoil and underlying material ranges from strongly alkaline in the areas more severely affected by soluble salts to neutral in the less affected areas. The scabby, moderately saline-alkali areas are low in natural fertility. Tilth is poor: the soil is hard when dry and sticky when wet. The shrink-swell potential is high in the subsoil.

Most of the acreage of this soil is used for cultivated crops. A few areas are in introduced grasses for pasture.

This soil is poorly suited to grain sorghum, alfalfa, and small grains. The main concerns in management are reducing alkalinity and salinity and water erosion. If suitable outlets are available, surface drainage can be improved by reshaping the land. Applications of gypsum or sulfur may be needed to counteract the alkali. Because these amendments are expensive, soil tests should be made to determine the amount needed. Organic matter and plant nutrients can be increased by applying manure and fertilizer and by growing legumes in the cropping system. Leaving a cover of crop residue on the surface helps to prevent crusting after rains and reduces water erosion. Cutting for silage removes residue that is needed to reclaim the soil.

This soil is suited to tall wheatgrass for tame grass pasture.

This soil is poorly suited to trees and shrubs in windbreaks. The saline-alkali condition of the soil is the principal limitation. This limitation can be minimized by planting species that tolerate the salts.

This soil is not suitable for septic tank absorption fields because of slow permeability. Other sites should be found. Foundations for dwellings need to be strengthened and backfilled with coarser material to prevent damage by shrinking and swelling of the soil. 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. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. Mixing the base material with additives, such as hydrated lime, helps to prevent shrinking and swelling. Buried pipes must be coated because of salts in the soil.

This soil is in capability units IVs-1 dryland and IVs-1 irrigated, Saline Lowland range site, and windbreak suitability group 9N.

SoF—Sogn-Rock Outcrop complex, 11 to 30 percent slopes. This map unit consists of areas of a shallow, somewhat excessively drained Sogn soil closely intermingled with areas of limestone rock outcrops on moderately steep and steep uplands. The Sogn soil formed in loess and residuum weathered from limestone. It is on the upper parts of side slopes along drainageways. In places, the limestone outcrops consist of vertical escarpments. Areas range from 3 to 50 acres in size. This complex is 45 to 65 percent Sogn soil and 25 to 40 percent Rock Outcrop. Areas of the Sogn soil and of Rock Outcrop are so intermingled that it was not practical to separate them in mapping.

Typically, the Sogn soil has a surface layer of black, friable silty clay loam about 5 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 5 inches thick. Below this is limestone bedrock. In places, depth to limestone is 20 to 40 inches.

Included in mapping are small areas of Judson, Marshall, and Sharpsburg soils. Judson soils are deep to rock and are on foot slopes below the Sogn soil. Marshall and Sharpsburg soils formed in loess and are on the higher parts of the landscape. Included areas make up 10 to 20 percent of the unit.

Permeability of the Sogn soil is moderate above the limestone. Available water capacity is very low. Moisture is released readily to plants. Roots are restricted by the bedrock. Runoff is rapid on the Sogn soil and very rapid on the Rock Outcrop. In the Sogn soil the organic matter content is moderate and natural fertility is medium.

Nearly all of the acreage of this complex is in trees and native grass. It is used mainly for wildlife habitat and range and is a source of limestone.

This complex is not suited to cultivated crops because of the shallow depth to rock and the steep slopes.

Range is effective in controlling erosion. Grazing should be controlled to allow plants to become firmly established and maintained. Leaving half or more of the vegetation at the end of the growing season helps to maintain a healthy stand of grass. Proper grazing, deferred grazing, and a planned grazing system help to maintain or improve the range condition. In places, removal of woody shrubs is desirable so that grass can become the dominant vegetation.

This complex is not suitable for windbreaks. Some species can be hand planted in places. Bur oak, cedar, and hickory are the most common trees growing in these areas.

These soils are generally unsuitable for septic tank absorption fields or dwelling sites because of the shallow depth to bedrock and steep slopes. Other sites should be found. Cuts and fills are generally needed to provide a suitable grade for roads; however, digging is difficult because of bedrock and blasting is needed to reach the required depth.

This complex is in capability unit VIs-4 dryland, Shallow Limy range site, and windbreak suitability group 10.

ThE—Thurman loamy fine sand, 9 to 20 percent slopes. This deep, moderately steep, somewhat excessively drained soil is on uplands. The soil formed in sandy eolian material. It is on side slopes and narrow ridgetops. The areas range from 5 to 100 acres in size.

Typically, the surface layer is very dark grayish brown, very friable loamy fine sand about 10 inches thick. The next layer is very dark grayish brown, very friable loamy fine sand about 11 inches thick. The underlying material is dark yellowish brown and light yellowish brown fine sand to a depth of 60 inches.

Included with this soil in mapping are small areas of finer textured Marshall and Monona soils. These soils make up about 15 percent of the unit.

Permeability is rapid, and available water capacity is low. Moisture is readily absorbed and released to plants. Runoff is medium because of the slope. Organic matter content is moderately low, and natural fertility is medium.

Most of the acreage of this soil is in trees and grass. It is used mainly for grazing and wildlife habitat. A few areas are cultivated.

This soil is generally unsuited to cultivated crops because of the steepness of slope and the hazard of erosion.

This soil is suited to introduced grasses for pasture. Pastures generally consist of smooth brome and areas of switchgrass or sand lovegrass. Overgrazing can easily result in wind erosion. Proper stocking and rotation grazing help to keep grasses in good condition.

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

This soil is suited to trees and shrubs in windbreaks. Planting on the contour and maintaining strips of sod between the rows can prevent water erosion. In some areas the trees or shrubs can be planted by hand. Bur oak commonly grows on this soil.

This soil is generally not suited to recreational use because of the moderately steep slopes. Camp sites, picnic areas, and playgrounds should be located on adjacent soils that are not as steep or on areas that have been shaped and leveled. Paths and trails should run on the contour.

This soil readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent, which may pollute the ground water. Dwellings need to be designed to fit the slope, or the soil can be graded to an acceptable slope. Cuts and fills are generally needed to provide a suitable grade for roads.

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

Ud—Udorthents, silty. These nearly level soils are the overburden from a nearby quarry. Areas are irregular in shape and range from 10 to 50 acres in size.

Typically, the soil material is silty clay loam and silt loam with various size stones mixed throughout. The colors are mixed and are similar to the subsoil and underlying material of the original soil. In some places the Udorthents are less than 60 inches thick over the underlying buried soil.

Permeability is moderately slow or moderate, depending on the original soil material. Available water capacity is moderate. Organic matter content and natural fertility are low.

Most acreage of this map unit is cultivated. A few areas are in introduced grasses.

These soils are poorly suited to cultivated crops. The main limitation is the stones. Increasing the content of organic matter and improving fertility are the main concerns in management. Row crops can be grown several years in succession if weeds, insects, and plant diseases are controlled. Conservation tillage practices that leave crop residue on the soil surface help to conserve soil moisture. Returning crop residue to the soil helps to improve organic matter content and increase intake of water. Use of fertilizer or legumes improves fertility.

These soils are suited to grasses and legumes for pasture. Smooth brome, orchardgrass, tall fescue, and reed canarygrass grow well. A legume in the planting increases forage production. Fertilizer should be applied according to soil tests. Proper stocking, rotation grazing, weed control, and timely mowing keep grasses vigorous.

These soils are poorly suited to windbreaks. Some species can be hand planted in places.

This map unit requires onsite investigation to determine suitability and management requirements for engineering uses.

These soils are in capability unit IVs-9 dryland and windbreak suitability group 10.

Wt—Wymore silty clay loam, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is on wide ridgetops on the uplands. The soil formed in loess. Individual areas range from 5 acres to over 400 acres in size.

Typically, the surface layer is very dark brown, friable silty clay loam about 6 inches thick. The subsurface layer is also very dark brown, friable silty clay loam. It is about 3 inches thick. The subsoil is about 40 inches thick. The upper part is dark brown, firm silty clay; the next part is brown and grayish brown, firm silty clay; and the lower part is grayish brown, firm silty clay loam. The underlying material is light brownish gray silty clay loam to a depth of 60 inches. Mottles are present in the lower part of the subsoil and below.

Included with this soil in mapping are small areas of Sharpsburg soils and of poorly drained silty soils. Sharpsburg soils contain less clay in the subsoil. The poorly drained silty soils are in small depressions. Included soils make up about 10 percent of the unit.

Permeability is slow, and available water capacity is high. Moisture is released slowly to plants. Runoff is slow. A perched seasonal high water table is at a depth of 1 to 3 feet in spring of some years. This soil dries slowly during spring and during prolonged rainy periods, but upon drying it develops cracks and becomes hard. Organic matter content is moderate, and natural fertility is high. The shrink-swell potential of the subsoil is high.

Most of the acreage of this soil is cultivated.

This soil is best suited to grain sorghum and wheat, the most common crops. Corn, soybeans, and alfalfa are also grown. Cultivated crops may suffer moisture stress during hot, dry periods in summer when the plants are in the critical stage of development. Grain sorghum is the most drought-resistant crop grown. The clayey subsoil restricts root penetration and the movement of air and water. Regulation of the plant population according to the amount of soil moisture, timely tillage, and return of crop residue to the soil surface are good management practices. Plant residue returned to the soil increases the intake of water and helps to maintain organic matter content. Soil compaction is reduced and soil structure is preserved by timely tillage or by working the soil when it is not too wet in spring. The use of fertilizer and legumes helps to maintain fertility.

This soil is suited to gravity and sprinkler irrigation. Corn, grain sorghum, alfalfa, and soybeans can be grown in irrigated areas. Irrigation water should be applied at the proper time and in proper amounts.

This soil is suited to grasses and legumes in pasture. Smooth brome and tall fescue grow well. Forage production can be increased by including a legume in the planting. Fertilizer should be applied according to soil tests. Proper stocking, timely mowing, and rotation grazing help to keep the grasses vigorous.

This soil is suited to trees and shrubs in windbreaks. Survival of adapted species is good, and growth is fair. Weeds and grasses can be controlled by cultivation between the rows with conventional equipment and by hand hoeing, rototilling, and using appropriate herbicides in the rows.

This soil is not suitable for septic tank absorption fields because of slow permeability and wetness. Other sites should be found. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. Constructing dwellings on raised, well compacted fill material avoids wetness caused by the perched seasonal high water table. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. Damage to roads 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 soil is in capability units IIs-2 dryland and IIs-1 irrigated, Clayey range site, and windbreak suitability group 4L.

WtC—Wymore silty clay loam, 2 to 5 percent slopes. This deep, gently sloping, moderately well drained soil is on upland side slopes and ridgetops. The soil formed in loess. Individual areas range from 5 acres to over 300 acres in size.

Typically, the surface layer is very dark brown, friable silty clay loam about 9 inches thick. The subsoil is about 39 inches thick. The upper part of the subsoil is very dark grayish brown, firm silty clay; the middle part is dark grayish brown, firm silty clay; and the lower part is grayish brown, firm silty clay. The underlying material is grayish brown silty clay loam to a depth of 60 inches.

Included with this soil in mapping are small areas of Judson and Sharpsburg soils. Judson soils are on foot slopes. Judson and Sharpsburg soils have less clay in the subsoil. These soils make up about 10 percent of the unit.

Permeability is slow, and available water capacity is high. Moisture is released slowly to plants. Runoff is medium. A perched seasonal high water table is at a depth of 1 to 3 feet in spring of some years. This soil dries slowly during spring and during prolonged rainy periods; but upon drying it develops cracks and becomes hard. Organic matter content is moderate, and natural fertility is high. The shrink-swell potential of the subsoil is high.

Most of the acreage of this soil is cultivated.

This soil is best suited to grain sorghum and wheat. Corn, soybeans, and alfalfa are also grown. Cultivated crops may suffer during hot, dry periods in summer when the plants are in critical stages of development. Grain sorghum is more resistant to drought. The main concerns in management are maintaining organic matter content, tilth, and fertility and controlling erosion. Conservation tillage practices that leave crop residue on the soil surface help to conserve soil moisture. Returning crop residue to the soil helps to maintain and improve organic matter content and increase the intake of water. The use of fertilizer or legumes helps to maintain fertility. Contour farming, terraces, and grassed waterways control erosion and conserve moisture.

This soil is suited to gravity and sprinkler irrigation. Corn, grain sorghum, and alfalfa can be grown in irrigated areas. Erosion is the main hazard. Irrigation water should be applied at the proper time and in proper amounts. Conservation tillage practices that keep crop residue on the surface help to control erosion and reduce the runoff rate.

This soil is suited to grasses and legumes for pasture. Smooth brome is the most common grass used in pastures. Alfalfa can be grown to increase forage production. Fertilizer should be applied according to soil tests. Proper stocking, timely mowing, and rotation grazing help to keep the grasses vigorous.

This soil is suited to trees and shrubs in windbreaks. Survival of adapted species is good, and growth is fair. Competition for moisture from weeds and grasses can be eliminated by cultivating between the rows and by hand hoeing, rototilling, or using appropriate herbicides in the row.

This soil is not suitable for septic tank absorption fields because of slow permeability and wetness. Other sites should be found. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. Constructing dwellings on raised, well compacted fill material avoids wetness caused by the perched seasonal high water table. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. Damage to roads 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 soil is in capability units IIIe-2 dryland and IIIe-1 irrigated, Clayey range site, and windbreak suitability group 4L.

WtC2—Wymore silty clay loam, 2 to 5 percent slopes, eroded. This deep, gently sloping, moderately well drained soil is on upland side slopes and narrow ridgetops. The soil formed in loess. Individual areas range from 5 acres to over 1,000 acres in size. Erosion has removed much of the original dark surface soil over most of the area.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 4 inches thick. The subsoil is about 30 inches thick. The upper part of the subsoil is dark brown, firm silty clay; the next part is brown, firm silty clay; the middle part is dark yellowish brown, firm silty clay; the next part is yellowish brown, friable silty clay loam; and the lowest part is light olive brown, friable silty clay loam. The underlying material is light olive brown silty clay loam to a depth of 60 inches. In some places, the surface layer is thicker.

Included with this soil in mapping are small areas of Colo, Judson, Mayberry, Nodaway, Pawnee, and Sharpsburg soils. Frequently or occasionally flooded Colo and Nodaway soils are along narrow drainageways and have less clay. Judson soils are on foot slopes and have less clay in the subsoil. Mayberry and Pawnee soils are on lower parts of the side slopes and formed in glacial till. Sharpsburg soils have less clay in the subsoil. Included soils make up 5 to 20 percent of the unit.

Permeability is slow, and available water capacity is high. Moisture is released slowly to plants. Runoff is medium. A perched seasonal high water table is at a depth of 1 to 3 feet in spring of some years. Cracks that develop during dry periods increase initial water intake during rains. Organic matter content is moderately low, and natural fertility is medium. Tilth is fair. The clayey subsoil limits root penetration and restricts water movement. The shrink-swell potential is high.

Most of the acreage of this soil is cultivated.

This soil is best suited to grain sorghum and wheat, the most commonly grown crops. Corn, soybeans, and alfalfa are also grown. Grain sorghum survives better in hot, dry periods than corn. Water erosion is the main problem. Moisture should be conserved by practices that slow or prevent runoff. Maintenance of fertility, organic matter content, and tilth are also management concerns. Contour farming, terraces, and grassed waterways control runoff and erosion. Returning crop residue to the soil helps to maintain and improve organic matter content, tilth, and intake of water. The use of fertilizer or legumes helps to maintain fertility. Excessive compaction by tillage should be avoided, particularly when the soil is wet, because compaction further reduces the permeability to air and water.

This soil is suited to sprinkler irrigation. Corn, grain sorghum, and alfalfa can be grown in irrigated areas. Erosion is the main hazard. Irrigation water should be applied at the proper time and in proper amounts. Conservation tillage practices that keep crop residue on the surface help to control erosion and runoff.

This soil is suited to grasses and legumes for pasture and hay. Smooth brome is the most common grass used in pasture. Alfalfa in the planting increases forage production. Fertilizer should be applied according to the soil tests. Proper stocking, timely mowing, and rotation grazing help to keep the grass and soil in good condition.

This soil is suited to trees and shrubs in windbreaks. Survival of adapted species is good, and growth is fair. Competition for moisture from weeds and grasses can be eliminated by cultivating between the rows and by hand hoeing, rototilling, or using appropriate herbicides in the row. Planting trees and shrubs on the contour helps to reduce erosion.

This soil is not suitable for septic tank absorption fields because of slow permeability and wetness. Other sites should be found. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. Constructing dwellings on raised, well compacted fill material avoids wetness caused by the perched seasonal high water table. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. Damage to roads 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 soil is in capability units IIIe-2 dryland and IVe-1 irrigated, Clayey range site, and windbreak suitability group 4L.

WtD2—Wymore silty clay loam, 5 to 9 percent slopes, eroded. This deep, strongly sloping, moderately well drained soil is on upland side slopes. The soil formed in loess. Individual areas range from 3 acres to over 250 acres in size. Erosion has removed most of the original dark surface soil, and tillage has mixed part of the clayey subsoil into the plow layer.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 5 inches thick. The subsoil is about 23 inches thick. The upper part of the subsoil is brown, firm silty clay; the next part is olive brown, friable silty clay loam; the next part is light olive brown, friable silty clay loam; and the lowest part is light brownish gray, friable silty clay loam. The underlying material is light brownish gray silty clay loam to a depth of 60 inches. In some places, glacial till is 3 to 5 feet below the surface.

Included with this soil in mapping are small areas of Colo, Judson, Mayberry, Nodaway, Pawnee, and Sharpsburg soils. Colo and Nodaway soils are along narrow drainageways and are frequently or occasionally flooded. Judson soils have less clay in the subsoil and are on foot slopes. Mayberry and Pawnee soils formed in glacial till and are on lower parts of the side slopes. Sharpsburg soils are at higher positions and contain less clay. Included soils make up 5 to 20 percent of the unit.

Permeability is slow, and available water capacity is high. Moisture is released slowly to plants. Runoff is rapid. A perched seasonal water table is at a depth of 1 to 3 feet in spring of some years. Organic matter content is moderate, and natural fertility is medium. Tilth is fair. This soil is hard to work because of the clayey subsoil material that has been mixed into the surface layer. The shrink-swell potential is high.

Most of the acreage of this soil is cultivated. A few areas are in grass and legumes and are used for grazing or hay.

This soil is poorly suited to row crops. Grain sorghum, wheat, and alfalfa are commonly grown. Row crops should be limited. The hazard of water erosion is severe. Control of surface water, improvement of tilth, improvement of organic matter content, and maintenance of fertility are concerns in management. Terraces, grassed waterways, and contour farming help to control erosion and runoff. Returning crop residue to the soil improves organic matter content, tilth, and intake of water. Use of fertilizer and legumes helps to maintain fertility.

This soil is suited to grasses and legumes for pasture or hay. Smooth brome is commonly grown. Permanent grass is effective in controlling erosion. Fertilizer should be applied according to soil tests. Rill erosion is a hazard on overgrazed pasture. Proper stocking, timely mowing, and rotation grazing help to keep the grass and soil in good condition.

This soil is suited to trees and shrubs in windbreaks. Establishing windbreaks can be difficult because of the thin surface layer and the clayey subsoil. Special care is needed when the trees are planted and as they become established. Competition for moisture from weeds and grasses can be eliminated by cultivating between the rows and by hand hoeing, rototilling, or using appropriate herbicides in the row. Planting trees on the contour helps to prevent erosion. Terraces are also helpful.

This soil is not suitable for septic tank absorption fields because of slow permeability and wetness. Other sites should be found. Foundations for dwellings need to be strengthened and backfilled with coarse material to prevent damage by shrinking of the soil. Constructing dwellings on raised, well compacted fill material avoids wetness caused by the perched seasonal high water table. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. Damage to roads 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 soil is in capability unit IVe-2 dryland, Clayey range site, and windbreak suitability group 4L.

Zo—Zook silty clay loam, 0 to 2 percent slopes. This deep, nearly level, poorly drained soil is on bottom lands, generally back from the stream channel. This soil formed in alluvium. It is occasionally flooded. Individual areas are long and range from 5 to 200 acres in size.

Typically, the surface layer is black, friable silty clay loam about 6 inches thick. The subsurface layer is about 26 inches thick. The upper part of the subsurface layer is black, firm silty clay; and the lower part is very dark gray, very firm silty clay. The subsoil is very dark gray and dark gray, very firm silty clay about 12 inches thick. The underlying material is very dark gray silty clay to a depth of 60 inches. In some places, the subsoil has a few fine soft accumulations of lime. In places, the subsoil contains less clay.

Included with this soil in mapping are small areas of moderately well drained Nodaway soils. Nodaway soils are closer to the stream channel and make up about 10 percent of the map unit.

Permeability is slow, and available water capacity is moderate. Moisture is released to plants slowly. Runoff is slow. The seasonal high water table rises to a depth of about 1 foot in most wet years and to a depth of about 3 feet in most dry years. Organic matter content is high, and natural fertility is high. Tilth is fair. The shrink-swell potential is high.

Most of the acreage of this soil is cultivated. The rest is mainly in grasses.

This soil is suited to corn, grain sorghum, and soybeans. Row crops can be grown several years in succession if weeds, plant diseases, and insects are controlled. Proper placement of rows, land grading, and installation of tile drains improve drainage. Outlets are generally available. This soil dries slowly in spring and during rainy periods, so cultivation, planting, and harvesting of crops are commonly delayed. Returning crop residue to the soil helps to maintain organic matter content and soil structure. Applying fertilizer helps to maintain fertility.

Under irrigation, this soil is suited to row crops, such as corn, grain sorghum, and soybeans. Gravity and sprinkler systems are suitable. Wetness is the main problem. Land leveling can improve surface drainage and increase irrigation efficiency.

This soil is suited to grasses for pasture or hay. Pastures commonly consist of smooth brome or other introduced grasses. Overgrazing or grazing when the soil is too wet can cause compaction and poor tilth. Proper stocking, timely mowing, and rotation grazing help to keep the grass in good condition.

This soil is suited to windbreaks of trees and shrubs that tolerate occasional wetness. Weeds and grasses can be controlled by cultivating between the rows with conventional equipment and by applying appropriate herbicides, hand hoeing, or rototilling near the trees.

This soil is generally unsuitable for dwelling sites and septic tank absorption fields because of flooding, wetness, and slow permeability. Other sites should be found. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. Constructing roads above flood level and providing adequate side ditches and culverts help to protect roads from flood damage and wetness. Damage to roads 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 soil is in capability units IIw-4 dryland and IIw-2 irrigated, Clayey Overflow range site, and windbreak suitability group 2W.

Zp—Zook silty clay, 0 to 1 percent slopes. This deep, nearly level, poorly drained soil is on bottom lands. The soil formed in alluvium. It is occasionally flooded. Individual areas are generally irregular in shape and range from 5 to 200 acres in size.

Typically, the surface layer is about 21 inches thick. The upper part of the surface layer is black, firm silty clay; and the lower part is very dark gray, very firm silty clay with dark yellowish brown mottles. The subsoil is very dark gray, very firm silty clay to a depth of 60 inches. The upper part of the subsoil has dark yellowish brown mottles. In a few places, the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Colo soils. These soils have less clay in the subsoil and are at the higher positions. Included soils make up about 10 percent of the map unit.

Permeability is slow, and available water capacity is moderate. The soil absorbs and releases moisture slowly. Runoff is slow. The seasonal high water table rises to a depth of about 1 foot in most wet years and to a depth of about 3 feet in most dry years. Organic matter content is moderate, and natural fertility is high. Tilth is poor. The silty clay texture and firm consistency of the surface layer make this soil difficult to work. The clayey soil restricts root penetration and the movement of water and air. The shrink-swell potential is high.

Most of the acreage of this soil is cultivated. A few areas are in introduced grasses and are used for pasture.

This soil is suited to corn, soybeans, grain sorghum, small grains, and alfalfa. Row crops can be grown several years in succession. Soil wetness early in spring when rainfall is highest is the main problem. Tillage should be kept to a minimum to avoid compaction. The soil is flooded occasionally, but damage to crops is seldom severe. Surface water stands in low areas for several days after rains, delaying tillage. Proper placement of rows, land leveling, and surface ditching improve drainage. If there are suitable outlets, drainage tile can be used to intercept underground water. Returning crop residue to the soil helps to maintain organic matter content and soil structure. Applying fertilizer helps to maintain fertility.

Under irrigation, this soil is suited to row crops, such as corn, grain sorghum, and soybeans. Gravity and sprinkler systems are suitable. Wetness is the main problem. Tillage is delayed early in the spring. Land leveling can improve surface drainage and increase irrigation efficiency.

Smooth brome, tall fescue, and reed canarygrass are well suited to introduced grass pasture. A legume in the planting increases forage production and opens the dense subsoil. Overgrazing or grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking, rotation grazing, and applying nitrogen fertilizer help to keep the grasses vigorous.

This soil is suited to trees in windbreaks. Survival and growth of species that tolerate occasional wetness are good. Weeds and grasses can be controlled by cultivating between the rows with conventional equipment and by applying appropriate herbicides or rototilling in the tree rows. Establishing seedlings can be a problem during wet periods. A light cultivation and supplemental watering can be used to close the cracks that form during dry periods.

This soil is generally unsuitable for dwelling sites and septic tank absorption fields because of flooding, wetness, and slow permeability. Other sites should be found. The surface pavement and base material of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained base material can be used to improve performance. 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 and wetness. Mixing the base material with hydrated lime increases strength and helps to prevent excessive shrinking and swelling. Damage to roads 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 helps to provide the needed surface drainage.

This soil is in capability units IIIw-1 dryland and IIIw-1 irrigated, Clayey Overflow range site, and windbreak suitability group 2W.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and 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; for windbreaks; 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

By William E. Reinsch, conservation agronomist, Soil Conservation Service

Most of the farmland in Cass County is under cultivation. In 1974, 93 percent of the acreage in farms was used for crops. The largest acreage is in soybeans and corn, followed by sorghum, wheat, and alfalfa hay. About 2 percent of the cropland is irrigated.

The soils of Cass County are well suited to cultivated crops if they are well managed. The Sharpsburg and Marshall soils make up most of the acreage used for crops.

General management needed for crops and pasture is suggested in this section. The crops and 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.

MANAGEMENT OF DRYFARMED CROPLAND

Good management of dryfarmed cropland reduces runoff and risk of erosion, conserves moisture, and improves tilth. Most of the soils in Cass County are suitable for the production of crops. In many areas, however, the severe erosion hazard needs to be reduced.

Water erosion is a major problem on about 75 percent of the acreage that has potential for crops. Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced when the fertile surface layer is lost. Loss of the surface layer is especially damaging to soils that have a clayey subsoil, such as Wymore and Pawnee soils. Second, the sediment produced from erosion pollutes streams. Control of erosion minimizes the pollution of streams by sediment and improves the quality of water for livestock and recreation uses and for fish and wildlife.

The overall hazard of erosion can be reduced if the more productive soils are used for row crops and the steeper, more erodible soils are used for close-growing crops, such as wheat, rye, alfalfa, or hay and pasture. A cropping sequence that keeps plant cover on the soil for extended periods reduces soil erosion so that the productive capacity of the soil is not decreased.

Erosion control practices provide protective surface cover, reduce runoff, and increase infiltration. Terraces, contour farming, grassed waterways, contour stripcropping, and conservation tillage systems can be used in Cass County (fig. 11). No-till and till-plant systems for row crops reduce erosion on sloping land. These tillage systems can be adapted to most soils in the county. Terraces and diversions reduce the length of slopes and thereby reduce runoff and erosion. These practices are most effective on deep, well drained soils that have regular slopes. Terraces and contour farming increase the effectiveness of conservation tillage systems.

The hazard of wind erosion is minor in Cass County, but management practices similar to those that control water erosion can be used to control erosion by wind. Conservation tillage, crop residue management, wind stripcropping, and narrow field windbreaks help to control wind erosion.

In intensive cropping systems, crop residue is important in water conservation, maintenance of soil fertility, and erosion control. Standing crop stubble will trap snow on the field (fig. 12) and limit evaporation. Crop residue returned to the soil helps to maintain fertility and improve tilth for future crops. Two tons of crop residue per acre contains about 20 pounds of nitrogen, 10 pounds of available phosphate, and about 30 pounds of potash. Soil bulk density is reduced by returning residue to the soil, and crusting problems and fuel requirements for tillage are reduced by lowering soil density. Crop residue left on the surface also helps to control erosion.

Herbicides control weeds; however, care must be taken to apply the correct kind at the proper rate to correspond with soil conditions. The colloidal clay and humus in the soil are responsible for the greatest part of the chemical activity of the soil. Therefore, application rates of herbicides should be lower on sandy soils (low in colloidal clay) and on soils with moderately low to low organic matter content to prevent crop damage from herbicides. Keeping field boundaries on the contour

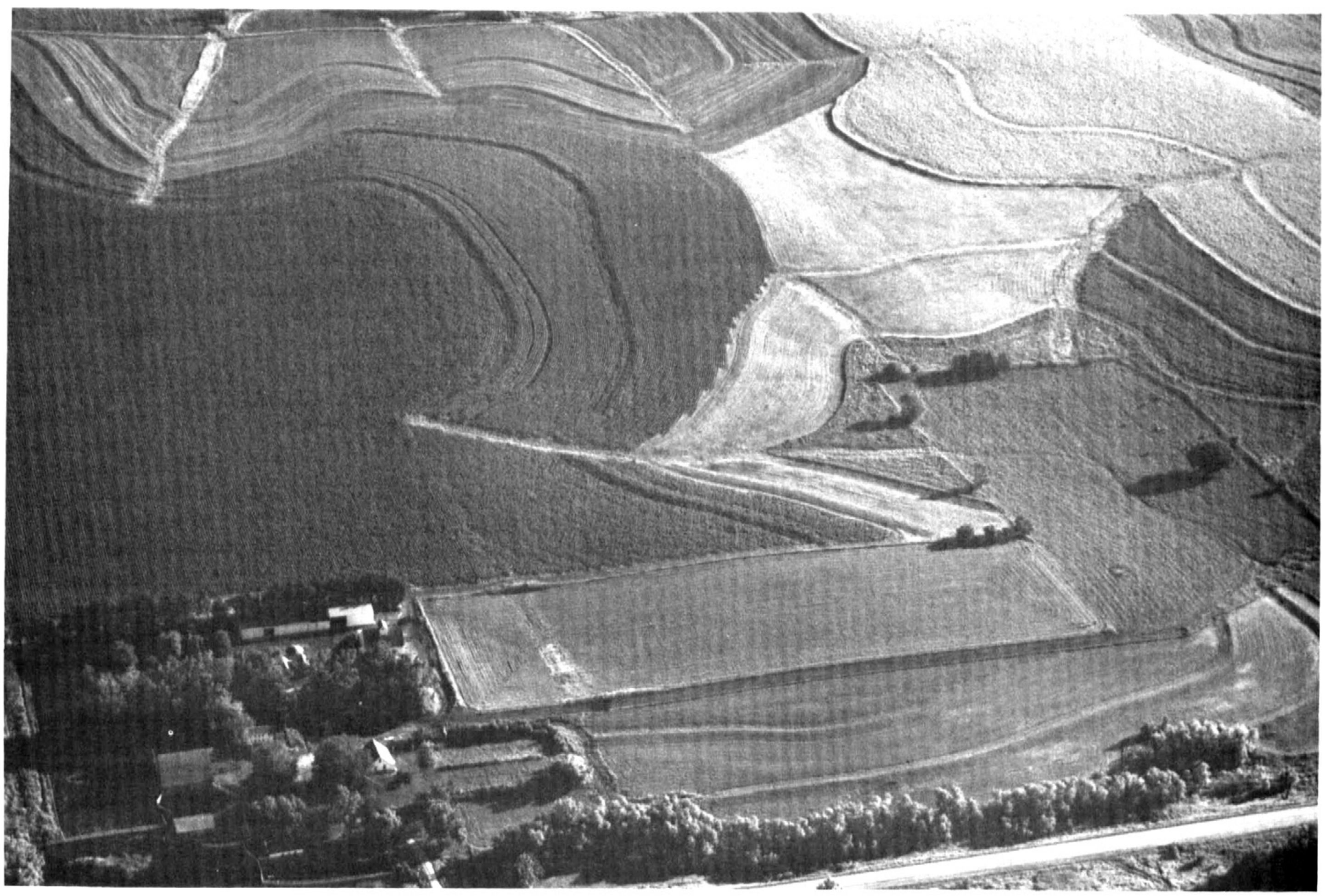

Figure 11.—Terraces, grassed waterways, and contour farming on Sharpsburg silty clay loam, 2 to 5 percent slopes.

Figure 12.—Standing corn stubble helps to trap snow on Wymore silty clay loam, 0 to 2 percent slopes.

helps to maintain organic matter content, thereby lessening the danger of damage from herbicides.

Additional nutrients are needed in some soils that are used for dryland crops. The kinds and amounts of fertilizer to be applied should be based on soil tests and on the content of moisture in the soil at the time of application. If the subsoil is dry and rainfall is low, the rate at which fertilizer is applied should be slightly lower than if the soil is moist. Nitrogen fertilizer is beneficial on all soils used for nonlegume crops. Phosphorus and zinc are needed on the more eroded areas or on areas that were excavated for construction of terraces or waterways. Dryland crops require smaller amounts of fertilizer than irrigated crops because the plant population and the supply of available moisture are generally lower.

MANAGEMENT OF IRRIGATED CROPLAND

Corn is the main irrigated crop. Sprinkler irrigation is the most commonly used method. It can be used on the more sloping soils; however, erosion control practices are needed. Surface irrigation is suitable for gently sloping soils, but such soils are subject to water erosion if irrigated and to wind erosion if plowed in fall.

The same conservation practices that control water erosion on dryfarmed cropland apply to irrigated areas as well. Terraces, contour farming, use of crop residue, and conservation tillage systems that leave a protective cover on the surface after planting increase water intake, slow runoff, and reduce erosion. In addition, they improve tilth.

Irrigation management regulates the application of water to obtain good crop growth without wasting soil or water. Furrow irrigation or surface irrigation is most efficient if maximum stream size is used down each row and a tailwater recovery system catches the water for reuse. Land leveling increases the efficiency of surface systems by distributing water evenly. Contour bench or contour furrow irrigation can be used on soils having slope of 2 to 6 percent. These systems conserve rainfall as well as irrigation water. Center-pivot sprinkler systems are most effective if small amounts of water are applied at frequent intervals.

Irrigation is most efficient if the water is applied when no more than one-half of the available soil water has been used by the plants. That is, if a soil can hold 8 inches of available water, irrigation should begin when about 4 inches of water has been removed by the crop. Irrigation should replace the water that has been used by the crop.

Irrigated crops generally produce higher yields than dryfarmed crops. Consequently, more plant nutrients, particularly nitrogen and phosphorus, are removed from the soil at harvest. Returning all crop residue to the soil and adding barnyard manure and commercial fertilizer help to supply the needed plant nutrients. If the soils have been disturbed during land leveling, and particularly if the topsoil has been removed, phosphorus and zinc, as well as nitrogen, are desirable. The kinds and amounts of fertilizer needed should be determined by soil tests.

All of the soils suitable for irrigation are placed in irrigation design groups, which are indicated by the Arabic number of the capability unit designation. Assistance in planning and design of an irrigation system is available from the local office of the Soil Conservation Service. Estimates of the cost of irrigation equipment can be obtained from local dealers and manufacturers.

MANAGEMENT FOR PASTURE AND HAY

Hay or pasture should be managed for maximum production. A planned grazing system that meets the needs of the plants and promotes uniform utilization of forage is important for high returns. 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 grasses and legumes can be grown on many kinds of soil, and with proper management they return a fair profit. Grasses and legumes are compatible with grains in the crop rotation and help to build up the soil. Because grasses and legumes improve tilth, add organic matter, and reduce erosion, they are ideal for use in a conservation cropping system.

Grasses that have potential for nonirrigated pasture 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, can provide high quality forage during summer. Switchgrass, indiangrass, and big bluestem are suitable.

The grasses most commonly grown on irrigated pasture are smooth brome and orchardgrass. Other grasses that are suited to irrigated pasture in this county are intermediate wheatgrass, meadow brome, and creeping foxtail. Irrigated pasture in Cass County can produce 750 to 900 pounds of beef per acre under a high level of management. Irrigated pasture is an economic alternative to irrigated cropland, and pasture controls erosion.

Legumes suitable for irrigated or nonirrigated pasture are alfalfa, birdsfoot trefoil, and cicer milkvetch.

Grasses and legumes that are used for pasture and hay, either irrigated or nonirrigated, require additional nutrients for maximum vigor and growth. The kinds and amounts of fertilizer to be applied should be determined by soil tests.

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.

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 for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The 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. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

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

Class I soils have few limitations that restrict their use.

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

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

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main 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-1 or IIIe-2.

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, 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. The soil quality, growing season, and moisture supply are suitable for economically producing sustained high yields of crops if the land 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 is of major importance in satisfying the nation's short- and long-term needs for food and fiber. The supply of high quality farmland is limited, however, and it should be used with wisdom and foresight.

Prime farmland must either be currently used for producing food or fiber or be available for this use. It may be in crops, pasture, timber, or other uses except urban or built-up land or water areas.

Prime farmland usually has an adequate and dependable supply of moisture for precipitation or irrigation. Temperature and growing season are favorable. It has acceptable reaction and has few or no rocks, and it is permeable to water and air. Prime farmland is not excessively erodible. It is not saturated with water for long periods and is not frequently flooded during the growing season. Slope ranges mainly from 0 to 6 percent.

About 156,370 acres—nearly 44 percent—of Cass County is prime farmland.

A recent trend in land use of some parts of the county has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland may shift cultivation to marginal lands, which generally are more erodible, more droughty, and more difficult to cultivate and are usually less productive.

The map units that make up prime farmland in Cass County are listed in table 7. This list does not constitute a recommendation for a particular land use. The extent of each map unit is given in table 4. Their locations are shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described in the section "Detailed Soil Map Units."

Soils that have a high water table, flooding, or inadequate rainfall may qualify as prime farmland if the limitations are overcome by drainage, flood control, or irrigation. Onsite evaluation is necessary to see if the limitations have been overcome by corrective measures.

Rangeland

By Peter N. Jensen, range conservationist, Soil Conservation Service

The acreage of range and native pasture is very small in Cass County. The rangeland is generally small tracts in the steep to rolling areas associated with the Missouri River broken land.

Various kinds of range produce different kinds and amounts of native grass. Each soil can be placed in a *range site* according to the kind and amount of vegetation that grows on the soil when the site is in excellent condition. To properly manage range, livestock producers need to know the different range sites and the plants that can grow on them. Then they can so manage the range to favor the growth of the best forage plants on each kind of land. The range sites for the soils in Cass County are given at the end of the detailed map unit descriptions.

Management practices that maintain or improve the condition of the grasses are needed in all areas of range. Proper grazing and deferred grazing or rest are the two most important practices. Another practice that improves the range is establishing native grasses by seeding improved or wild strains. Users who want to reseed cropland to native grasses or need other technical assistance can obtain help from the local office of the Soil Conservation Service. The interpretations for the range sites in the county are also available from the local SCS office.

Native Woodland

By Keith A. Ticknor, forester, Soil Conservation Service

Approximately 5.2 percent (18,200 acres) of Cass County is forested. The woodland is scattered throughout the county as small, irregular tracts along streams, on steep uplands, and on the low bottom lands of the Missouri River. Some fairly large blocks of woodland grow on the bluffs of the Missouri River.

Most of the wooded areas are in private ownership and occupy only a small part of the farms. Sawtimber in the woodland consists of 36 percent bur oak and white oak, 16 percent eastern cottonwood, 10 percent northern red oak and black oak, 6 percent green ash, 5 percent hackberry, 4 percent American basswood, 3 percent black walnut, and 20 percent other species, such as American elm, black willow, silver maple, red mulberry, boxelder, honeylocust, bitternut hickory, shagbark hickory, and osageorange. Most of these trees, especially the oaks, eastern cottonwood, black walnut, green ash, and hickories, have commercial value. However, only a small part of the woodland is managed for commercial production.

Since 1955, woodland acreage has declined approximately 34 percent. Most of this decline is the result of clearing woodland and converting it to crops or pasture.

Most of the soils in Cass County have good potential for the production of sawtimber, firewood, Christmas trees, and other wood products, but most of these soils are in crops and are unlikely to be converted to woodland. The stream bottoms can produce high value wood products within a short period of time in contrast to low value, long rotation products in the uplands. Small isolated areas that are difficult to farm are suitable for woodland.

Windbreaks and Environmental Plantings

By Keith A. Ticknor, forester, Soil Conservation Service

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 greatest protection.

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.

Most farmsteads in Cass County have trees around them that either were present when the farmstead was established or have been planted at various times. Tree planting around the farmstead is 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.

Siberian elm is the most common tree found around farmsteads, especially in older windbreaks. Some of the other windbreak trees are eastern redcedar, ponderosa pine, Austrian pine, Scotch pine, green ash, hackberry, honeylocust, Russian-olive, silver maple, and boxelder.

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.

Field windbreaks and hedgerows are numerous in the county along fence lines or property boundaries. These were planted to mark property lines, for a source of fenceposts, and to provide living fences.

In order for windbreaks to fulfill their intended purpose, the 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 towards insuring survival and a maximum rate of growth in the windbreak. Soil depth, texture, wetness, permeability, available water capacity, and fertility greatly affect the growth of trees and shrubs.

Trees and shrubs can be established easily on most soils in Cass County. Competition from weeds and grasses causes most failures in windbreak planting; therefore, proper site preparation and control of weeds after planting are the major concerns when establishing and managing a windbreak.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. 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

By Robert O. Koerner, biologist, Soil Conservation Service

Cass County has many public and private recreation areas. Potential is high for vacation cabins, cottages and homesites, camping, fishing, hunting, natural scenic and historic areas, and shooting preserves.

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public 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 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking or horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

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

By Robert O. Koerner, biologist, Soil Conservation Service

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 10, 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, oats, and grain sorghum.

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 orchardgrass, bromegrass, clover, 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 bluestem, goldenrod, beggarweed, wheatgrass, and 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 oak, cottonwood, cherry, sweetgum, ash, willow, and Russian mulberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, honeysuckle, and Peking cotoneaster.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, cedar, and juniper.

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, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

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, pheasant, meadowlark, field sparrow, cottontail, and red fox.

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 thrushes, woodpeckers, squirrels, red fox, raccoon, deer, and opossum.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

The Kennebec-Colo-Zook, Nodaway-Judson-Colo, and Haynie-Sarpy-Onawa associations offer the greatest diversity of wildlife habitat in Cass County. Heavily wooded areas are interspersed with grassland and cropland. These provide suitable habitat for woodland wildlife as well as hawks and owls. Water is available in numerous ponds and streams.

The Sharpsburg, Sharpsburg-Sogn, and Sharpsburg-Fillmore associations offer diversity for openland wildlife. Rolling hills and grassed waterways are common. Where waterways are to be established, the woody cover should be kept to provide travel courses and escape cover for wildlife. Grain sorghum and wheat provide food and cover for pheasant and bobwhite quail. Steeper areas are in pasture and range and provide nesting cover for upland game birds. Scattered clumps of plum, chokecherry, mulberry, and ash on the hillsides and in fence rows and drainageways add variety and furnish nesting sites for songbirds and mourning doves.

The Wymore and Mayberry-Nodaway-Pawnee associations harbor openland wildlife, primarily pheasant, along with bobwhite quail where there are areas of woodland and grassland. Farmstead windbreaks, brushy fence rows, and grassed waterways provide cover. Cropland provides food for wildlife, and many small ponds and springs provide water.

The Marshall and Monona associations harbor openland and woodland wildlife. Deep wooded stream corridors lead directly to the Missouri and Platte Rivers. These corridors provide travel lanes for deer and other wildlife from the river to the bluffs, which are heavily wooded with hackberry, mulberry, dogwood, ash, and oak. Many other wildlife species, such as fox, coyote, tree squirrels, cottontail rabbits, raccoon, opossums, hawks, owls, eagles, and songbirds frequent these associations. Mourning doves are common throughout the county, especially where open water is present.

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.

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 11 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 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, 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, 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, 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 12 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 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, 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 and bedrock 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 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, 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 or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help 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 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is 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 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome;

moderate if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability 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 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, 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. 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 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 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 18.

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 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, 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 18.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

Physical and Chemical Properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated 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 earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 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 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter 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 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the 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.

In table 17, some soils are assigned to two hydrologic groups. The first letter is for drained areas, and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, 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 the average, no more than once in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; 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 17 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is 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.

Mechanical and Chemical Analysis

Samples from soil profiles are collected for mechanical and chemical analysis by the Soil Conservation Service (*7*). Two pedons of Sharpsburg soils were collected in Cass County. Pedons of Burchard, Marshall, Monona, Morrill, Pawnee, Sharpsburg, and Wymore soils were sampled in nearby counties.

This information is useful to soil scientists in classifying soils and in developing concepts of soil genesis. It is also helpful in estimating available water capacity, susceptibility to wind erosion, fertility, tilth, and other aspects of the soil that influence management.

Engineering Index Test Data

Table 18 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 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); and Particle density—T 100 75I (AASHTO). Group index for the AASHTO classification was computed by the Nebraska modification system.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*8*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 19 shows the classification of the soils in the survey area. 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 Udoll (*Ud*, meaning humid, 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 Argiudolls (*Argi*, meaning argillic horizon, plus *udoll*, the suborder of the Mollisols that have a humid 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 Argiudolls.

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 fine, montmorillonitic, mesic Typic Argiudolls.

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 (*6*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*8*). Unless otherwise stated, colors in the descriptions are for moist 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."

Albaton Series

The Albaton series consists of deep, poorly drained soils on bottom lands. Permeability is very slow. These soils formed in alluvium. Slope is 0 to 1 percent.

Albaton soils are near Haynie, Onawa, and Sarpy soils. Haynie soils are silty. Onawa soils are silty in the lower part of the profile. Sarpy soils are sandy.

Typical pedon of Albaton silty clay, 0 to 1 percent slopes, 900 feet north and 200 feet east of center of sec. 32, T. 10 N., R. 14 E.

Ap—0 to 6 inches; very dark grayish brown (2.5Y 3/2) silty clay, dark grayish brown (2.5Y 4/2) dry; moderate medium subangular blocky structure parting to weak fine granular; very hard, firm; slight effervescence; mildly alkaline; abrupt smooth boundary.

C—6 to 60 inches; stratified very dark grayish brown (2.5Y 3/2), dark grayish brown (2.5Y 4/2), and grayish brown (2.5Y 5/2) silty clay and clay, dark grayish brown (2.5Y 4/2), grayish brown (2.5Y 5/2), and light brownish gray (2.5Y 6/2) dry; few fine distinct yellowish brown (10YR 5/6) and common fine distinct strong brown (7.5YR 4/6) mottles in some strata; horizontal cleavage between some strata which part to moderate fine subangular blocky structure; few calcium carbonate concretions in some strata; slight effervescence in the upper part and strong effervescence in the lower part; mildly alkaline.

The solum, which is the A horizon, ranges from 5 to 10 inches in thickness.

The A horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 or 5 dry), and chroma of 1 or 2. It is dominantly silty clay or clay but in places has silty clay loam strata. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5 (5 or 6 dry), and chroma of 1 or 2, but thin strata may be darker. It is mostly silty clay or clay, but some pedons have coarser textures below a depth of 40 inches. Reaction is mildly alkaline or moderately alkaline.

Burchard Series

The Burchard series consists of deep, well drained soils on uplands. Permeability is moderately slow. These soils formed in calcareous glacial till. Slope ranges from 6 to 11 percent.

Burchard soils are similar to Morrill soils and are near Mayberry, Morrill, Pawnee, Sharpsburg, and Wymore soils. Mayberry and Pawnee soils have more clay in the B horizon. Mayberry soils are redder in color. Morrill soils are redder in color and have a coarser substratum. Sharpsburg and Wymore soils have more clay in the B horizon, formed in loess, and are at higher positions than Burchard soils.

Typical pedon of Burchard clay loam in an area of Burchard-Morrill clay loams, 6 to 11 percent slopes, 2,200 feet east and 1,300 feet north of the southwest corner of sec. 31, T. 10 N., R. 11 E.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.

BA—7 to 12 inches; dark brown (10YR 3/3) clay loam, brown (10YR 5/3) dry; weak very fine subangular blocky structure; slightly hard, friable; neutral; clear smooth boundary.

Bt1—12 to 20 inches; dark brown (10YR 4/3) clay loam, yellowish brown (10YR 5/4) dry; moderate fine subangular blocky structure; hard, friable; neutral; clear smooth boundary.

Bt2—20 to 29 inches; light olive brown (2.5Y 5/4) clay loam, light yellowish brown (2.5Y 6/4) dry; moderate medium subangular blocky structure; hard, firm; common medium soft accumulations of segregated lime; strong effervescence; neutral; gradual smooth boundary.

Bt3—29 to 33 inches; light yellowish brown (2.5Y 6/4) clay loam, pale yellow (2.5Y 7/4) dry; weak medium subangular blocky structure; hard, firm; common medium soft accumulations of segregated lime; strong effervescence; mildly alkaline; gradual smooth boundary.

BC—33 to 44 inches; light yellowish brown (2.5Y 6/4) clay loam, pale yellow (2.5Y 7/4) dry; weak coarse subangular blocky structure; hard, firm; common iron and manganese oxides; common medium soft accumulations of segregated lime; strong effervescence; mildly alkaline; gradual smooth boundary.

C—44 to 60 inches; light brownish gray (2.5Y 6/2) and light yellowish brown (2.5Y 6/4) clay loam, light gray (2.5Y 7/2) and pale yellow (2.5Y 7/4) dry; massive; hard, firm; few iron and manganese oxides; common fine accumulations of segregated lime; strong effervescence; mildly alkaline.

The solum ranges from 30 to 50 inches in thickness. The mollic epipedon ranges from 8 to 15 inches in thickness. The depth to carbonates ranges from 20 to 30 inches.

The A horizon has color value of 2 or 3 (3 to 5 dry) and chroma of 1 or 2. It is dominantly clay loam but in places is loam. The B horizon has hue of 10YR or 2.5Y, value of 3 to 6 (5 to 7 dry), and chroma of 3 or 4. The C horizon has hue of 10YR or 2.5Y, value of 6 (6 or 7 dry), and chroma of 2. It has few to many fine to large mottles.

Colo Series

The Colo series consists of deep, somewhat poorly drained or poorly drained soils on bottom lands. Permeability is moderately slow. These soils formed in alluvium. Slope ranges from 0 to 2 percent.

These soils are less permeable than is defined for the Colo series. Also, the Colo soil in map unit Co is somewhat poorly drained, and the Colo soil is map unit Cp is more stratified. These differences, however, do not affect the use or behavior of the soils.

Colo soils are near Judson, Kennebec, Nodaway, and Zook soils. Judson, Kennebec, and Nodaway soils are better drained. Judson and Kennebec soils are in slightly higher positions than Colo soils. Nodaway soils are stratified higher in the profile. Zook soils have more clay in the subsoil.

Typical pedon of Colo silty clay loam, 0 to 2 percent slopes, 1,400 feet east and 400 feet north of the southwest corner of sec. 29, T. 12 N., R. 9 E.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; slightly hard, friable; medium acid; abrupt smooth boundary.

A1—7 to 15 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; slightly hard, friable; medium acid; clear smooth boundary.

A2—15 to 26 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; slightly hard, friable; medium acid; gradual smooth boundary.

Bw—26 to 37 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; few fine faint dark yellowish brown (10YR 4/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; hard, firm; slightly acid; gradual smooth boundary.

Cg1—37 to 42 inches; black (5Y 2/1) and very dark gray (5Y 3/1) silty clay loam, dark gray (5Y 4/1) and gray (5Y 5/1) dry; massive; hard, firm; slightly acid; gradual smooth boundary.

Cg2—42 to 60 inches; black (5Y 2/1) silty clay loam, dark gray (5Y 4/1) dry; massive; hard, firm; slightly acid.

The solum ranges from 36 to 52 inches in thickness. The mollic epipedon is more than 36 inches thick.

The A horizon has color value of 2 or 3 (3 or 4 dry) and chroma of 0 or 1. It is typically silty clay loam but in places is silt loam. It is medium acid to neutral. Some pedons have an AC horizon instead of a B horizon, and some pedons have neither. The B and C horizons have hue of 10YR, 2.5Y, or 5Y or are neutral; value is 2 to 5 (4 to 7 dry), and chroma is 0 to 2. They are slightly acid or neutral.

Fillmore Series

The Fillmore series consists of deep, poorly drained soils in depressions on uplands and stream terraces. Permeability is very slow. These soils formed in loess. Slope is 0 to 1 percent.

Fillmore soils are near Sharpsburg and Wymore soils. Sharpsburg and Wymore soils do not have an E horizon and are moderately well drained.

Typical pedon of Fillmore silt loam, 0 to 1 percent slopes, 2,000 feet north and 175 feet east of the southwest corner of sec. 22, T. 12 N., R. 9 E.

Ap—0 to 9 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak fine granular structure; slightly hard, friable; medium acid; abrupt smooth boundary.

E—9 to 19 inches; dark gray (10YR 4/1) silt loam, light gray (10YR 6/1) dry; moderate thin platy structure parting to weak fine granular; soft, very friable; few hard ferromanganese pellets; slightly acid; abrupt smooth boundary.

Bt1—19 to 26 inches; very dark gray (10YR 3/1) silty clay, dark grayish brown (10YR 4/2) dry; few fine faint brown (7.5YR 4/4) mottles; strong medium angular blocky structure; very hard, very firm; neutral; clear smooth boundary.

Bt2—26 to 35 inches; very dark grayish brown (10YR 3/2) silty clay, grayish brown (10YR 5/2) dry; strong coarse and medium angular blocky structure; very hard, very firm; neutral; clear smooth boundary.

Bt3—35 to 41 inches; dark grayish brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) dry; moderate coarse and medium subangular blocky structure; very hard, very firm; neutral; few hard pellets; clear smooth boundary.

BC—41 to 48 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; few fine faint yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; very hard, very firm; neutral; gradual smooth boundary.

C—48 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; few fine faint yellowish brown (10YR 5/6) mottles; massive; hard, firm; few medium lime concretions; neutral.

Thickness of the solum and depth to carbonates range from 36 inches to over 60 inches.

The A horizon has color value of 2 or 3 (4 or 5 dry) and chroma of 1 or 2. It is medium acid or slightly acid. The E horizon has color value of 4 or 5 (5 or 6 dry) and chroma of 1. The Bt horizon has value of 2 to 4 (3 to 5 dry) and chroma of 1 or 2. It is silty clay or clay and is medium acid to mildly alkaline. The BC and C horizons have hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. They are silty clay, silty clay loam, or silt loam. They are neutral to moderately alkaline.

Geary Series

The Geary series consists of deep, well drained soils on uplands. Permeability is moderately slow. These soils formed in silty material. Slope ranges from 6 to 11 percent.

The Geary soils in this county have a lighter colored surface layer than is defined for the series. This difference, however, does not alter the use or behavior of the soils.

Geary soils are near Mayberry, Sharpsburg, and Sogn soils. Mayberry and Sharpsburg soils have more clay in the B horizon. Sogn soils have limestone above a depth of 20 inches.

Typical pedon of Geary silty clay loam, 6 to 11 percent slopes, eroded, 420 feet north and 110 feet west of the southeast corner of sec. 30, T. 11 N., R. 12 E.

Ap—0 to 7 inches; dark brown (7.5YR 3/4) silty clay loam, brown (7.5YR 5/4) dry; weak fine granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.

BA—7 to 10 inches; dark brown (7.5YR 3/4) silty clay loam, brown (7.5YR 5/4) dry; weak fine subangular blocky structure; hard, friable; slightly acid; clear smooth boundary.

Bt1—10 to 23 inches; dark brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; weak medium prismatic structure parting to weak fine subangular blocky; hard, friable; slightly acid; gradual smooth boundary.

Bt2—23 to 35 inches; dark brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable; neutral; gradual smooth boundary.

Bt3—35 to 46 inches; dark brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; weak coarse subangular blocky structure; very hard, firm; neutral; gradual smooth boundary.

C1—46 to 54 inches; dark brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; massive; very hard, firm; neutral; gradual smooth boundary.

C2—54 to 60 inches; dark brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; massive; very hard, firm; neutral.

The solum ranges from 30 to 60 inches in thickness.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It is silt loam or silty clay loam and is slightly acid or medium acid. The B horizon has hue of 7.5YR or 5YR, value of 3 to 5 (4 to 6 dry), and chroma of 3 to 6. It typically is silty clay loam and less commonly clay loam. It is medium acid to mildly alkaline. The C horizon has hue of 5YR, 7.5YR, or 10YR, value of 4 or 5 (5 to 7 dry), and chroma of 3 to 6. It is slightly acid to moderately alkaline. It typically is silty clay loam but is clay loam, silt loam, or loam in places. Some pedons have secondary calcium carbonate concretions below a depth of 40 inches.

Haynie Series

The Haynie series consists of deep, moderately well drained soils on bottom lands. Permeability is moderate. These soils formed in alluvium. Slope ranges from 0 to 2 percent.

Haynie soils are near Albaton, Onawa, and Sarpy soils. Albaton soils are poorly drained and have more clay throughout the profile. Onawa soils have more clay in the upper part of the profile. Sarpy soils are coarser textured throughout the profile.

Typical pedon of Haynie silt loam, 0 to 2 percent slopes, 850 feet west and 1,000 feet south of the northeast corner of sec. 27, T. 11 N., R. 14 E.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, very friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

C—7 to 60 inches; stratified very dark grayish brown (10YR 3/2), dark grayish brown (10YR 4/2), and dark brown (10YR 4/3) silt loam and very fine sandy loam, grayish brown (10YR 5/2), light brownish gray (10YR 6/2), and pale brown (10YR 6/3) dry; few fine faint yellowish brown (10YR 5/6), common medium distinct strong brown (7.5YR 5/6), and common fine distinct yellowish brown (10YR 5/6) mottles; massive with horizontal cleavage; slightly hard, very friable; strong effervescence; mildly alkaline.

The solum, which is the A horizon, ranges from 6 to 10 inches in thickness. Most pedons have free carbonates within 10 inches of the surface.

The A horizon has color value of 3 (4 or 5 dry) and chroma of 2 or 3. It is silt loam or very fine sandy loam. The C horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 to 6 dry), and chroma of 2 or 3. It is typically stratified silt loam or very fine sandy loam, but it has strata of fine sand, loamy fine sand, fine sandy loam, or silty clay loam. Reaction is mildly alkaline or moderately alkaline.

Hedville Series

The Hedville series consists of shallow and very shallow, somewhat excessively drained soils on uplands. Permeability is moderate above the bedrock. These soils formed in material weathered from sandstone. Slope ranges from 6 to 20 percent.

Hedville soils are similar to Sogn soils and are near Marshall, Monona, and Sharpsburg soils. Sogn soils are underlain by limestone. Marshall, Monona, and Sharpsburg soils are deep, and they formed in loess.

Typical pedon of Hedville sandy loam, 6 to 20 percent slopes, 1,250 feet north and 400 feet west of the southeast corner of sec. 26, T. 12 N., R. 10 E.

A1—0 to 10 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; medium acid; gradual smooth boundary.

A2—10 to 15 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 4/3) dry; 15 to 20 percent by volume sandstone fragments; weak fine granular structure; slightly hard, friable; medium acid; clear irregular boundary.

R—15 inches; yellowish brown partially weathered sandstone.

Thickness of the solum ranges from 4 to 20 inches and is the same as the depth to sandstone. The mollic epipedon ranges from 4 to 18 inches in thickness.

The A horizon has color value of 2 or 3 (4 or 5 dry) and chroma of 1 or 2. It is dominantly sandy loam but in places is fine sandy loam or loam with 10 to 25 percent sandstone fragments. It is medium acid to neutral. Some pedons have a B or C horizon.

Ida Series

The Ida series consists of deep soils on uplands. They are well drained, somewhat excessively drained, and excessively drained. Permeability is moderate. These soils formed in calcareous loess. Slope ranges from 11 to 60 percent.

The Ida soils in map units IdF and MoG are more excessively drained than is defined for the Ida series. This difference, however, does not alter the use or behavior of the soils.

Ida soils are near Judson and Monona soils. Judson soils do not contain carbonates, have a thicker surface layer, and are on concave foot slopes. Monona soils have carbonates at greater depths and have a thicker surface layer.

Typical pedon of Ida silt loam, 17 to 30 percent slopes, 1,800 feet east and 2,300 feet south of the northwest corner of sec. 28, T. 10 N., R. 14 E.

A—0 to 7 inches; dark grayish brown (10YR 4/2) silt loam, brown (10YR 5/3) dry; weak fine granular structure; slightly hard, very friable; neutral; clear smooth boundary.

C1—7 to 17 inches; dark yellowish brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; weak fine granular structure; slightly hard, very friable; few calcium carbonate nodules; strong effervescence; mildly alkaline; gradual smooth boundary.

C2—17 to 30 inches; yellowish brown (10YR 5/4) silt loam, light yellowish brown (10YR 6/4) dry; few fine faint yellowish brown (10YR 5/6) relict mottles; massive; slightly hard, very friable; few calcium carbonate nodules; strong effervescence; mildly alkaline; gradual smooth boundary.

C3—30 to 60 inches; yellowish brown (10YR 5/4) silt loam, light yellowish brown (10YR 6/4) dry; common medium distinct light brownish gray (10YR 6/2) and few fine distinct yellowish brown (10YR 5/6) relict mottles; massive; slightly hard, very friable; strong effervescence; mildly alkaline.

The solum, which is the A horizon, ranges from 6 to 10 inches in thickness. The depth to free carbonates ranges from 0 to 10 inches.

The A horizon has color value of 3 to 5 (4 to 6 dry) and chroma of 2 or 3. Reaction is neutral or mildly alkaline. The C horizon has value of 4 to 6 (5 to 7 dry) and chroma of 3 to 6. Reaction is mildly alkaline or moderately alkaline.

Judson Series

The Judson series consists of deep, well drained or moderately well drained soils on foot slopes. Permeability is moderate. These soils formed in noncalcareous silty colluvium. Slope ranges from 0 to 6 percent.

Judson soils are similar to Kennebec soils and are near Colo, Kennebec, Marshall, Sharpsburg, and Wymore soils. Colo soils are poorly drained and are at lower positions in the landscape. Kennebec soils have a thicker A horizon, do not have a B horizon, and have chroma of 2 below a depth of 36 inches. Marshall, Sharpsburg, and Wymore soils have a thinner A horizon, have more clay in the B horizon, and are at higher positions.

Typical pedon of Judson silt loam, 2 to 6 percent slopes (fig. 13), 1,090 feet south and 100 feet east of the northwest corner of sec. 8, T. 11 N., R. 11 E.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak medium granular structure; slightly hard, friable; medium acid; abrupt smooth boundary.

A1—6 to 14 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak medium granular structure; slightly hard, friable; slightly acid; gradual smooth boundary.

A2—14 to 22 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; slightly hard, friable; slightly acid; gradual smooth boundary.

AB—22 to 34 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; hard, friable; slightly acid; gradual smooth boundary.

Bw—34 to 52 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; moderate medium subangular blocky structure; hard, friable; slightly acid; gradual smooth boundary.

BC—52 to 60 inches; brown (10YR 4/3) silty clay loam, dark yellowish brown (10YR 4/4) dry; weak medium subangular blocky structure; hard, friable; slightly acid.

The solum ranges from 40 inches to more than 60 inches in thickness. The mollic epipedon ranges from 24 to 52 inches in thickness.

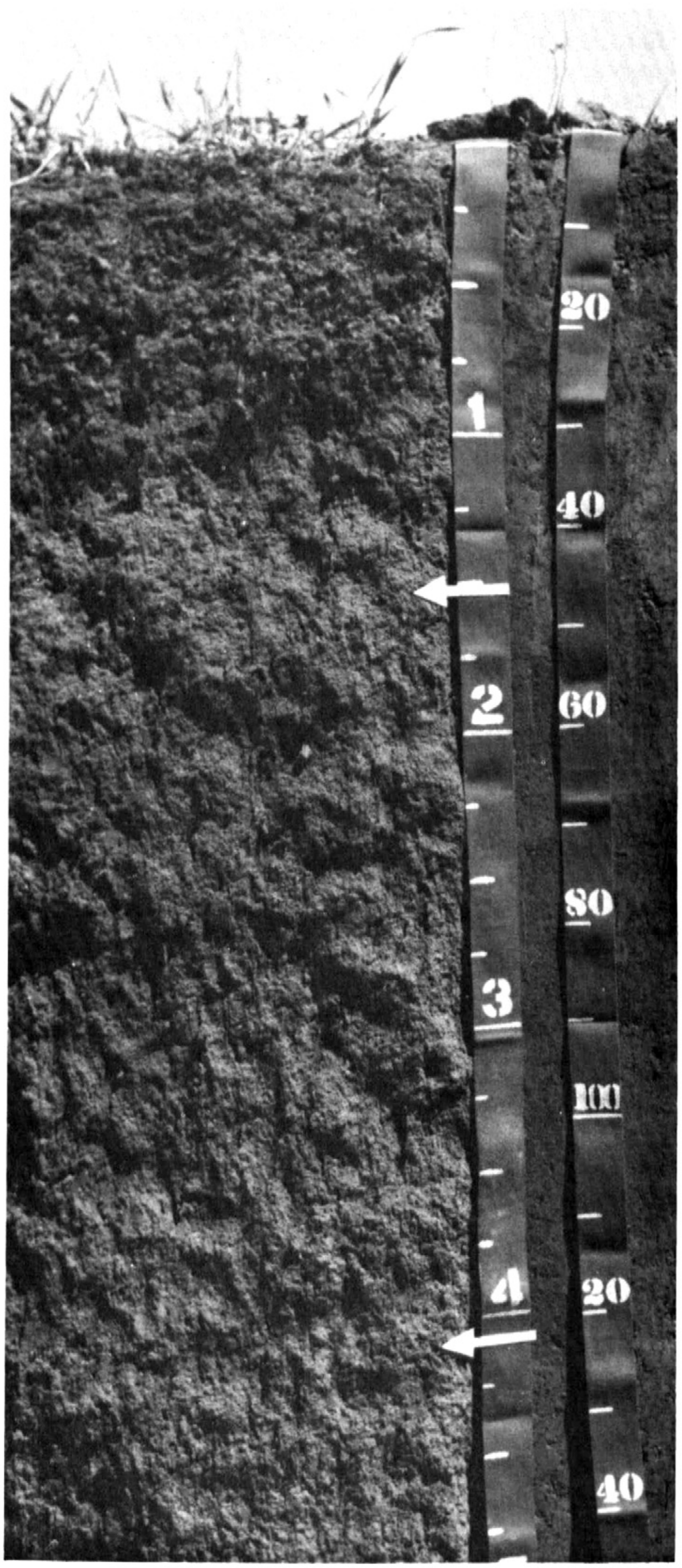

Figure 13.—Profile of Judson silt loam. This soil is deep and moderately well drained. Scale in feet and centimeters.

The A horizon has color value of 2 or 3 (3 or 4 dry) and chroma of 1 or 2. It is silt loam or silty clay loam. It is medium acid or neutral. The B and C horizons have color value of 3 to 5 (4 to 6 dry) and chroma of 2 to 4. They are slightly acid or neutral. Some pedons have mottles in the lower part of the B horizon and the C horizon.

Kennebec Series

The Kennebec series consists of deep, moderately well drained soils on bottom lands. Permeability is moderate. These soils formed in alluvium. Slope ranges from 0 to 2 percent.

Kennebec soils are similar to Judson soils and are near Colo, Judson, and Nodaway soils. Colo soils contain more clay throughout the profile and are poorly drained. Judson soils have brighter colors within 36 inches of the surface and are at higher positions. Nodaway soils do not have a mollic epipedon and are more stratified higher in the profile.

Typical pedon of Kennebec silt loam, 0 to 2 percent slopes, 350 feet south and 100 feet east of the northwest corner of sec. 20, T. 12 N., R. 9 E.

Ap—0 to 6 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.

A1—6 to 20 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard, friable; medium acid; diffuse smooth boundary.

A2—20 to 33 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; slightly hard, friable; medium acid; diffuse smooth boundary.

AC—33 to 42 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; slightly hard, friable; medium acid; diffuse smooth boundary.

C1—42 to 48 inches; stratified black (10YR 2/1) and very dark grayish brown (10YR 3/2) silt loam, dark gray (10YR 4/1) and light brownish gray (10YR 6/2) dry; massive; slightly hard, friable; slightly acid; diffuse smooth boundary.

C2—48 to 60 inches; stratified very dark gray (10YR 3/1) and black (10YR 2/1) silt loam, dark gray (10YR 4/1) and light brownish gray (10YR 6/2) dry; few fine faint dark yellowish brown (10YR 4/6) mottles; massive; slightly hard, friable; slightly acid.

The solum and the mollic epipedon are more than 36 inches thick.

The A horizon has color value of 2 or 3 (3 or 4 dry) and chroma of 1 or 2. It is dominantly silt loam but in places is silty clay loam. It is medium acid or slightly acid. The C horizon has color value of 2 to 4 (3 to 5 dry) and chroma of 1 to 3. It is silt loam or silty clay loam. It is medium acid to neutral.

Marshall Series

The Marshall series consists of deep, well drained soils on uplands. Permeability is moderate. These soils formed in loess. Slope ranges from 2 to 17 percent.

Marshall soils are similar to Monona soils and are near Judson, Monona, and Sharpsburg soils. Judson soils have a thicker surface horizon and are on foot slopes. Monona soils have less clay in the subsoil. Sharpsburg soils have more clay in the subsoil.

Typical pedon of Marshall silty clay loam, 2 to 5 percent slopes, 2,100 feet north and 150 feet west of the southeast corner of sec. 18, T. 12 N., R. 13 E.

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

A—6 to 10 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; medium acid; clear smooth boundary.

AB—10 to 14 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; slightly hard, friable; slightly acid; clear smooth boundary.

Bw1—14 to 17 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; moderate fine subangular blocky structure; slightly hard, friable; slightly acid; gradual smooth boundary.

Bw2—17 to 24 inches; dark brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; hard, friable; slightly acid; gradual smooth boundary.

Bw3—24 to 33 inches; dark brown (10YR 4/3) silty clay loam, yellowish brown (10YR 5/4) dry; weak medium prismatic structure parting to moderate medium subangular blocky; hard, friable; slightly acid; gradual smooth boundary.

BC—33 to 45 inches; dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable; slightly acid; gradual smooth boundary.

C—45 to 60 inches; yellowish brown (10YR 5/4) silty clay loam, light yellowish brown (10YR 6/4) dry; few fine faint grayish brown (2.5Y 5/2) and few fine faint yellowish brown (10YR 5/6) mottles; massive; slightly hard, friable; few fine dark bodies; neutral.

The solum ranges from 40 to 55 inches in thickness. The mollic epipedon ranges from 10 to 24 inches in thickness.

The A horizon has color value of 2 or 3 (4 or 5 dry) and chroma of 1 or 2. It is dominantly silty clay loam but in places is silt loam. Reaction is medium acid or slightly acid. The B horizon has color value of 3 to 5 (4 to 6 dry) and chroma of 2 to 4. In some pedons, few grayish brown relict mottles are present in the lower part of the B horizon. The B horizon is medium acid to neutral. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 or 6 dry), and chroma of 2 to 4, often with brown and gray relict mottles. It is slightly acid or neutral.

In map units MaD2 and MaE2, the solum is thinner and the A horizon is lighter in color and thinner than is defined for the Marshall series. In map unit MaD, the pH is lower throughout the solum than is defined for the series. These differences, however, do not affect the use or behavior of the soils.

Mayberry Series

The Mayberry series consists of deep, moderately well drained soils on uplands. Permeability is slow. These soils formed in material reworked from glacial deposits. Slope ranges from 6 to 11 percent.

The Mayberry soils in this county have a lighter colored surface layer than is defined for the series. This difference, however, does not alter the use or behavior of the soils.

Mayberry soils are similar to Pawnee soils and are near Geary, Morrill, Pawnee, Sharpsburg, and Wymore soils. Geary and Morrill soils have less clay in the Bt2 horizon, and Geary soils formed in loess. Pawnee soils formed in glacial till and are not as reddish brown as Mayberry soils. Sharpsburg and Wymore soils formed in loess and are at higher positions.

Typical pedon of Mayberry silty clay loam, 6 to 11 percent slopes, eroded, 900 feet south and 100 feet west of the northeast corner of sec. 36, T. 10 N., R. 9 E.

Ap—0 to 6 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; weak fine granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.

BA—6 to 10 inches; dark brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; moderate fine subangular blocky structure; hard, firm; thin dark brown (10YR 3/3) coatings on peds; medium acid; clear smooth boundary.

Bt1—10 to 19 inches; dark brown (7.5YR 4/4) clay, brown (7.5YR 5/4) dry; moderate fine subangular blocky structure; hard, firm; medium acid; clear smooth boundary.

Bt2—19 to 24 inches; dark brown (7.5YR 4/4) clay, brown (7.5YR 5/4) dry; weak medium prismatic structure parting to moderate medium subangular blocky; hard, firm; slightly acid; gradual smooth boundary.

Bt3—24 to 33 inches; dark brown (7.5YR 4/4) clay, brown (7.5YR 5/4) dry; weak medium prismatic structure parting to moderate medium subangular blocky; hard, firm; few dark brown oxides; slightly acid; gradual smooth boundary.
Bt4—33 to 43 inches; dark brown (7.5YR 4/4) clay, brown (7.5YR 5/4) dry; weak coarse subangular blocky structure; hard, firm; neutral; gradual smooth boundary.
BC—43 to 50 inches; dark brown (7.5YR 4/4) clay, brown (7.5YR 5/4) dry; weak coarse subangular blocky structure; hard, firm; neutral; gradual smooth boundary.
C—50 to 60 inches; yellowish brown (10YR 5/4) clay loam, light yellowish brown (10YR 6/4) dry; common medium distinct grayish brown (2.5Y 5/2) mottles; massive; hard, firm; few dark brown oxides; neutral.

The solum ranges from 40 to 60 inches in thickness.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 to 3. It is silty clay loam or clay loam. Reaction is medium acid or slightly acid. The Bt horizon has hue of 5YR or 7.5YR, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. It is typically clay and silty clay. It is medium acid to neutral. The C horizon has hue of 5YR, 7.5YR, or 10YR, value of 4 or 5 (5 to 7 dry), and chroma of 4 or 5. It is clay loam or clay with bands of coarser materials in places.

Monona Series

The Monona series consists of deep soils on uplands. They are dominantly well drained, but the moderately steep or steep soils are somewhat excessively drained or excessively drained. Permeability is moderate. These soils formed in loess. Slope ranges from 2 to 40 percent.

Monona soils are similar to Marshall soils and are near Ida, Judson, and Marshall soils. Ida soils have a thinner surface layer and have carbonates at shallower depths. Judson soils have a thicker surface layer and are on foot slopes below the Monona soils. Marshall soils have more clay in the subsoil.

Typical pedon of Monona silt loam, 2 to 5 percent slopes, 1,450 feet east and 100 feet south of the northwest corner of sec. 17, T. 11 N., R. 14 E.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.
A—6 to 12 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; slightly hard, friable; medium acid; clear smooth boundary.
BA—12 to 22 inches; dark brown (10YR 4/3) and very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) and dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; slightly hard, friable; slightly acid; clear smooth boundary.
Bw—22 to 35 inches; dark yellowish brown (10YR 4/4) silt loam, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure; slightly hard, friable; slightly acid; gradual smooth boundary.
C—35 to 60 inches; yellowish brown (10YR 5/4) silt loam, light yellowish brown (10YR 6/4) dry; few fine faint light brownish gray (2.5Y 6/2) and yellowish brown (10YR 5/6) mottles; massive; slightly hard, friable; neutral.

The solum ranges from 24 to 42 inches in thickness. Depth to carbonates ranges from 24 inches to more than 60 inches. Thickness of the mollic epipedon ranges from 10 to 18 inches.

The A horizon has color value of 2 or 3 (3 to 5 dry) and chroma of 1 or 2. It is slightly acid or medium acid. The B horizon has value of 3 to 5 (4 to 6 dry) and chroma of 3 or 4. It is dominantly silt loam, but in some pedons it has a thin layer of silty clay loam in the upper part. It is slightly acid or neutral. The C horizon has value of 4 or 5 (5 to 7 dry) and chroma of 3 to 6. It is neutral to moderately alkaline.

In map units MnD2 and MnE2, the A horizon is lighter in color and thinner than is defined for the Monona series. The Monona soils in map units MnF and MoG are somewhat excessively drained and excessively drained, whereas the Monona series is defined as consisting of well drained soils. These differences, however, do not affect the use or behavior of the soils.

Morrill Series

The Morrill series consists of deep, well drained soils on uplands. Permeability is moderately slow. These soils formed in reworked glacial deposits. Slope ranges from 6 to 11 percent.

Morrill soils are similar to Burchard and Geary soils and are near Burchard, Geary, Mayberry, Pawnee, Sharpsburg, and Wymore soils. Burchard soils contain carbonates. Geary soils are fine-silty. Mayberry, Pawnee, Sharpsburg, and Wymore soils are fine textured. Sharpsburg soils formed in loess.

Typical pedon of Morrill clay loam in an area of Burchard-Morrill clay loams, 6 to 11 percent slopes, 1,800 feet west and 1,600 feet north of the southeast corner of sec. 36, T. 10 N., R. 10 E.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.
BA—7 to 14 inches; dark brown (7.5YR 3/2) clay loam, brown (7.5YR 4/2) dry; weak medium subangular blocky structure parting to weak fine granular; hard, friable; medium acid; clear smooth boundary.

Bt1—14 to 22 inches; dark brown (7.5YR 4/4) clay loam, brown (7.5YR 5/4) dry; weak fine subangular blocky structure; hard, friable; medium acid; clear smooth boundary.

Bt2—22 to 29 inches; dark brown (7.5YR 4/4) sandy clay loam, brown (7.5YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable; medium acid; gradual smooth boundary.

BC—29 to 47 inches; dark brown (7.5YR 4/4) sandy clay loam, brown (7.5YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable; slightly acid; gradual smooth boundary.

C1—47 to 56 inches; brown (7.5YR 5/4) sandy loam, reddish yellow (7.5YR 6/6) dry; massive; slightly hard, friable; slightly acid; gradual smooth boundary.

C2—56 to 60 inches; brown (7.5YR 5/4) clay loam, light brown (7.5YR 6/4) dry; massive; hard; friable; few iron and manganese oxides; slightly acid.

The solum ranges from 30 to 50 inches in thickness. The mollic epipedon ranges from 10 to 20 inches in thickness.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 to 3. It is clay loam, loam, or sandy loam and is medium acid or slightly acid. The Bt horizon has hue of 7.5YR or 5YR, value of 3 or 4 (4 or 5 dry), and chroma of 3 to 5. It is clay loam or sandy clay loam and is medium acid to neutral. The C horizon has hue of 10YR or 7.5YR, value of 4 or 5 (4 to 6 dry), and chroma of 3 to 6. It is slightly acid or neutral.

In map unit MrD2, the surface layer is lighter in color and thinner than is defined for the Morrill series. These differences, however, do not affect the use or behavior of the soil.

Nodaway Series

The Nodaway series consists of deep, moderately well drained soils on bottom lands. Permeability is moderate. These soils formed in alluvium. Slope ranges from 0 to 2 percent.

Nodaway soils are near Colo, Judson, Kennebec, and Zook soils. Colo soils are poorly drained and have a gleyed subsoil. Judson and Kennebec soils have a thicker, darker A horizon. Zook soils have more clay in the subsoil and are poorly drained.

Typical pedon of Nodaway silt loam, 0 to 2 percent slopes, 600 feet west and 350 feet south of the northeast corner of sec. 4, T. 10 N., R. 11 E.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; neutral; abrupt smooth boundary.

C—7 to 60 inches; stratified very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) silt loam, dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) dry; massive but tending to platy because of stratification; slightly hard, friable; iron stains; neutral.

These soils are slightly acid or neutral throughout the profile.

The A horizon has color value of 2 or 3 (4 or 5 dry) and chroma of 1 to 3. It is 6 to 10 inches thick. The C horizon has color value of 3 to 5 (4 to 6 dry) and chroma of 1 to 4. It typically is stratified silt loam with layers of silty clay loam and very thin lenses of coarser material. Some pedons are sandy below a depth of 40 inches.

Onawa Series

The Onawa series consists of deep, somewhat poorly drained soils on bottom lands. Permeability is slow in the upper part and moderate in the lower part. These soils formed in alluvium. Slope ranges from 0 to 2 percent.

Onawa soils are near Albaton, Haynie, and Sarpy soils. Albaton soils are clayey throughout the profile. Haynie soils are silty throughout the profile. Sarpy soils are coarser textured than Onawa soils.

Typical pedon of Onawa silty clay, 0 to 2 percent slopes, 550 feet south and 2,500 feet west of the northeast corner of sec. 32, T. 10 N., R. 14 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; weak fine granular structure; hard, firm; mildly alkaline; abrupt smooth boundary.

Cg—8 to 27 inches; stratified very dark gray (5Y 3/1) and very dark grayish brown (2.5Y 3/2) clay and silty clay, dark gray (5Y 4/1) and grayish brown (2.5Y 5/2) dry; weak and moderate fine subangular blocky structure; very hard, very firm; mildly alkaline; clear smooth boundary.

2C—27 to 60 inches; stratified dark grayish brown (2.5Y 4/2) silt loam, very fine sandy loam, and silty clay loam, grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; thin platy strata resulting from deposition; hard, friable; strong effervescence; mildly alkaline.

The solum, which is the A horizon, ranges from 5 to 8 inches in thickness. Depth to the loamy 2C horizon ranges from 18 to 30 inches.

The A horizon has hue of 10YR or 2.5Y, value of 3 (4 or 5 dry), and chroma of 2. It is dominantly silty clay, but in some pedons it is silt loam or silty clay loam. The Cg horizon has hue of 2.5Y or 5Y, value of 3 or 4 (4 to 6 dry), and chroma of 1 or 2. Reaction is mildly alkaline or moderately alkaline. The 2C horizon is similar in color to the Cg horizon. The 2C horizon is typically silt loam or very fine sandy loam but in places includes thin strata of loamy fine sand and silty clay loam. Reaction is mildly alkaline or moderately alkaline.

Pawnee Series

The Pawnee series consists of deep, moderately well drained soils on uplands. Permeability is slow. These soils formed in glacial till. Slope ranges from 6 to 11 percent.

Pawnee soils are similar to Mayberry soils and are near Judson, Mayberry, Sharpsburg, and Wymore soils. Judson soils have less clay in the B horizon. Mayberry soils formed in reddish brown glacial till. Sharpsburg and Wymore soils formed in loess.

Typical pedon of Pawnee clay loam, 6 to 11 percent slopes, eroded, 2,150 feet north and 190 feet east of the southwest corner of sec. 30, T. 10 N., R. 9 E.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; weak medium granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.

Bt1—6 to 11 inches; dark brown (10YR 3/3) clay, brown (10YR 4/3) dry; weak medium subangular blocky structure; hard, firm; very dark grayish brown (10YR 3/2) coatings on peds; neutral; clear smooth boundary.

Bt2—11 to 16 inches; brown (10YR 4/3) clay, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; hard, firm; very dark grayish brown (10YR 3/2) coatings on peds; neutral; clear smooth boundary.

Bt3—16 to 27 inches; olive brown (2.5Y 4/4) clay, light olive brown (2.5Y 5/4) dry; strong medium angular blocky structure; hard, firm; thin dark brown (10YR 3/3) coatings on peds; mildly alkaline; gradual smooth boundary.

Bt4—27 to 34 inches; light olive brown (2.5Y 5/4) clay, light yellowish brown (2.5Y 6/4) dry; few fine faint yellowish brown (10YR 5/6) mottles; moderate medium angular blocky structure; hard, firm; strong effervescence in a few spots; mildly alkaline; gradual smooth boundary.

BC—34 to 42 inches; light olive brown (2.5Y 5/4) clay, light yellowish brown (2.5Y 6/4) dry; common medium prominent grayish brown (2.5Y 5/2) mottles; weak coarse angular blocky structure; hard, firm; few dark brown oxides; violent effervescence on a few lime-coated pebbles; mildly alkaline; gradual smooth boundary.

C1—42 to 55 inches; light olive brown (2.5Y 5/4) clay, light yellowish brown (2.5Y 6/4) dry; common medium prominent light brownish gray (2.5Y 6/2) and common fine prominent yellowish brown (10YR 5/6) mottles; massive; hard, firm; common dark brown oxides; slight effervescence; mildly alkaline; gradual smooth boundary.

C2—55 to 60 inches; light olive brown (2.5Y 5/4) clay loam, light yellowish brown (2.5Y 6/4) dry; common medium prominent light brownish gray (2.5Y 6/2) and common fine prominent yellowish brown (10YR 5/6) mottles; massive; hard, firm; few dark brown oxides; slight effervescence; mildly alkaline.

The solum ranges from 36 to 60 inches in thickness. The depth to free carbonates ranges from 26 to 50 inches. The mollic epipedon ranges from 10 to 18 inches in thickness. A few stones and pebbles are commonly on the surface and throughout the profile.

The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 or 2. It is dominantly clay loam but in places is loam or clay. It is medium acid or slightly acid. The B horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. Reaction is slightly acid to moderately alkaline. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6 (6 or 7 dry), and chroma of 2 to 4. It is dominantly clay and clay loam but in places is sandy clay loam. Reaction is mildly alkaline or moderately alkaline.

Sarpy Series

The Sarpy series consists of deep, excessively drained soils on bottom lands. Permeability is rapid. These soils formed in alluvium. Slope ranges from 0 to 3 percent.

Sarpy soils are near Albaton, Haynie, and Onawa soils. Albaton soils are poorly drained and have more clay throughout the profile. Haynie soils are silty. Onawa soils have more clay throughout the profile.

Typical pedon of Sarpy loamy fine sand in an area of Sarpy-Haynie complex, 0 to 3 percent slopes, 1,600 feet north and 2,640 feet east of the southwest corner of sec. 31, T. 13 N., R. 14 E.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine granular structure; soft, very friable; slight effervescence; neutral; clear smooth boundary.

C—6 to 60 inches; stratified dark brown (10YR 3/3), dark grayish brown (10YR 4/2), and brown (10YR 4/3) loamy fine sand and fine sand, brown (10YR 5/3), light brownish gray (10YR 6/2), and pale brown (10YR 6/3) dry; single grained; loose; slight effervescence; mildly alkaline.

Reaction is neutral to moderately alkaline throughout the profile. Most pedons have free carbonates throughout the profile.

The A horizon has color value of 3 or 4 (5 or 6 dry) and chroma of 2 or 3. It is dominantly loamy fine sand but in places is fine sand, loamy sand, very fine sandy loam, or sandy loam. The C horizon has color value of 3 to 5 (5 to 7 dry) and chroma of 2 or 3. It is stratified fine sand, very fine sand, loamy sand, or loamy fine sand. Some pedons have thin lenses of fine sandy loam or silt loam.

Sharpsburg Series

The Sharpsburg series consists of deep, moderately well drained soils on uplands and terraces. Permeability is moderately slow. These soils formed in loess. Slope ranges from 0 to 15 percent.

Sharpsburg soils are near Geary, Judson, Marshall, and Wymore soils. Geary, Judson, and Marshall soils have less clay in the Bt horizon. Wymore soils have more clay in the Bt horizon. Geary soils are redder in hue. Judson soils have a thicker surface horizon and are on foot slopes below the Sharpsburg soils.

Typical pedon of Sharpsburg silty clay loam, 2 to 5 percent slopes (fig. 14), 2,100 feet south and 100 feet west of the northeast corner of sec. 13, T. 11 N., R. 10 E.

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

A—6 to 10 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; slightly hard, friable; slightly acid; clear smooth boundary.

AB—10 to 14 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate very fine subangular blocky structure; slightly hard, friable; medium acid; clear smooth boundary.

Bt1—14 to 20 inches; dark brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; hard, friable; medium acid; gradual smooth boundary.

Bt2—20 to 26 inches; dark brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; moderate medium prismatic structure parting to moderate fine subangular blocky; hard, friable; medium acid; gradual smooth boundary.

Bt3—26 to 36 inches; dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable; slightly acid; gradual smooth boundary.

BC—36 to 45 inches; yellowish brown (10YR 5/4) silty clay loam, light yellowish brown (10YR 6/4) dry; few fine faint yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; hard, friable; few fine dark bodies; slightly acid; gradual smooth boundary.

C—45 to 60 inches; yellowish brown (10YR 5/4) and grayish brown (2.5Y 5/2) silty clay loam, light yellowish brown (10YR 6/4) and light gray (2.5Y 7/2) dry; few distinct brown (7.5YR 4/4) mottles; massive; hard, friable; few fine dark bodies; slightly acid.

Figure 14.—Profile of Sharpsburg silty clay loam. This deep, moderately well drained soil formed in loess. Scale in feet.

Thickness of the solum ranges from 42 to 60 inches. Thickness of the mollic epipedon ranges from 10 to 24 inches.

The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 to 3. Reaction ranges from strongly acid to slightly acid. The Bt horizon has value of 3 to 5 (4 to 6 dry) and chroma of 2 to 4. It is silty clay loam or silty clay that ranges from 36 to 42 percent clay. The BC and C horizons have hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. They are mottled. They are typically silty clay loam, but the lower part is silt loam in places.

In map units ShD2 and ShE2, the solum is thinner and the A horizon is lighter in color and thinner than is defined for the Sharpsburg series. These differences, however, do not affect the use or behavior of the soils.

Sharpsburg Variant

The Sharpsburg Variant consists of deep, moderately well drained soils on stream terraces and uplands. These soils are slightly to moderately affected by soluble salts. Permeability is slow. These soils formed in loess. Slope ranges from 1 to 4 percent.

Sharpsburg Variant soils are near Colo, Judson, Kennebec, and Sharpsburg soils. Colo, Judson, Kennebec, and Sharpsburg soils do not contain salts. Colo and Kennebec soils are on bottom lands.

Typical pedon of Sharpsburg Variant silty clay loam, 1 to 4 percent slopes, 2,500 feet west and 1,750 feet south of the northeast corner of sec. 23, T. 12 N., R. 9 E.

Ap—0 to 4 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; neutral; abrupt smooth boundary.

A—4 to 10 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; slightly hard, friable; moderately alkaline; clear smooth boundary.

Bt1—10 to 14 inches; dark brown (10YR 3/3) silty clay, brown (10YR 5/3) dry; moderate medium subangular blocky structure; hard, firm; moderately alkaline; clear smooth boundary.

Bt2—14 to 17 inches; dark brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; moderate medium subangular blocky structure; hard, firm; few fine visible salts; strong effervescence; moderately alkaline; clear smooth boundary.

Bt3—17 to 24 inches; yellowish brown (10YR 5/4) silty clay, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; hard, firm; few fine calcium carbonate concretions; few fine visible salts; slight effervescence; moderately alkaline; gradual smooth boundary.

BC—24 to 41 inches; yellowish brown (10YR 5/4) silty clay, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; hard, firm; few fine calcium carbonate concretions; strong effervescence; mildly alkaline; gradual smooth boundary.

C—41 to 60 inches; yellowish brown (10YR 5/4) silty clay, light yellowish brown (10YR 6/4) dry; massive; hard, friable; slight effervescence; mildly alkaline.

The solum ranges from 25 to 45 inches in thickness. The mollic epipedon ranges from 10 to 14 inches in thickness. Depth to visible salts ranges from 10 to 18 inches.

The A horizon has color value of 2 or 3 (4 or 5 dry) and chroma of 1 or 2. It is silty clay loam or silty clay. It is slightly acid to moderately alkaline. The B horizon has color value of 3 to 5 (4 to 6 dry) and chroma of 3 or 4. It is mildly alkaline or moderately alkaline and is silty clay loam or silty clay. The lower part of the B horizon has mottles in some pedons. The C horizon has color value of 5 or 6 (6 or 7 dry) and chroma of 3 or 4. It is mildly alkaline to strongly alkaline.

Sogn Series

The Sogn series consists of shallow, somewhat excessively drained soils on uplands. Permeability is moderate above the bedrock. These soils formed in thin layers of loess and residuum weathered from underlying limestone. Slope ranges from 11 to 30 percent.

Sogn soils are similar to Hedville soils and are near Geary, Judson, Marshall, and Sharpsburg soils. Hedville soils are underlain by sandstone. Geary, Judson, Marshall, and Sharpsburg soils are deep and formed in loess. Judson soils formed in colluvial material at lower positions.

Typical pedon of Sogn silty clay loam in an area of Sogn-Rock Outcrop complex, 11 to 30 percent slopes (fig. 15), 2,400 feet west of the northeast corner of sec. 5, T. 10 N., R. 12 E.

A1—0 to 5 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard, friable; neutral; clear smooth boundary.

A2—5 to 10 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; slightly hard, friable; few fragments of weathered limestone; neutral; abrupt smooth boundary.

R—10 inches; bedded indurated limestone that has joints and cracks filled with dark soil material.

Thickness of the solum and depth to limestone bedrock range from 4 to 20 inches. Some pedons contain up to 15 percent limestone fragments in the upper part of the profile.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 to 3. It is dominantly silty clay loam but in places is silt loam. It is slightly acid to mildly alkaline. The bedrock generally is dense and hard.

Figure 15.—Profile of Sogn silty clay loam. Depth to limestone bedrock ranges from 4 to 20 inches. Scale in feet.

Thurman Series

The Thurman series consists of deep, somewhat excessively drained soils on uplands. Permeability is rapid. These soils formed in sandy eolian material. Slope ranges from 9 to 20 percent.

The Thurman soils in this county have a slightly thicker dark surface soil and a more humid moisture regime than is defined for the series. These differences, however, do not alter the use or behavior of the soils.

Thurman soils are near Marshall and Monona soils. Marshall and Monona soils have more clay, more silt, and less sand throughout the profile than Thurman soils.

Typical pedon of Thurman loamy fine sand, 9 to 20 percent slopes, 445 feet south and 1,500 feet west of the northeast corner of sec. 29, T. 12 N., R. 11 E.

A1—0 to 5 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; weak fine granular structure; soft, very friable; slightly acid; abrupt smooth boundary.

A2—5 to 10 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; soft, very friable; slightly acid; clear smooth boundary.

AC—10 to 21 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; weak coarse subangular blocky structure; soft, very friable; slightly acid; gradual smooth boundary.

C1—21 to 27 inches; dark yellowish brown (10YR 4/4) fine sand, light yellowish brown (10YR 6/4) dry; single grained; loose; slightly acid; gradual smooth boundary.

C2—27 to 60 inches; light yellowish brown (10YR 6/4) fine sand, very pale brown (10YR 7/4) dry; single grained; loose; slightly acid.

The solum is 13 to 24 inches thick. Reaction is slightly acid or neutral throughout the profile.

The A horizon has color value of 2 or 3 (4 or 5 dry) and chroma of 1 or 2. It is dominantly loamy fine sand but in places is loamy sand, sandy loam, or very fine sandy loam. The C horizon has value of 4 to 6 (5 to 7 dry) and chroma of 3 or 4. It is fine sand or loamy fine sand.

Wymore Series

The Wymore series consists of deep, moderately well drained soils on uplands. Permeability is slow. These soils formed in loess. Slope ranges from 0 to 9 percent.

Wymore soils are similar to Mayberry and Pawnee soils and are near Judson, Mayberry, Pawnee, and Sharpsburg soils. Judson soils have less clay and are in lower landscape positions. Mayberry and Pawnee soils formed in glacial till. Sharpsburg soils have less clay and higher chroma in the argillic horizon.

Typical pedon of Wymore silty clay loam, 2 to 5 percent slopes, 150 feet north and 250 feet west of the southeast corner of sec. 24, T. 10 N., R. 9 E.

Ap—0 to 6 inches; very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.

A—6 to 9 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak medium granular structure; hard, friable; medium acid; clear smooth boundary.

Bt1—9 to 14 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; hard, firm; very dark brown (10YR 2/2) coatings on faces of peds; medium acid; clear smooth boundary.

Bt2—14 to 23 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; common fine faint yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure parting to moderate fine subangular blocky; very hard, firm; very dark grayish brown (10YR 3/2) coatings on faces of peds; slightly acid; gradual smooth boundary.

Bt3—23 to 32 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; common fine faint yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; very hard, firm; very dark grayish brown (10YR 3/2) coatings on faces of peds; slightly acid; gradual smooth boundary.

Bt4—32 to 39 inches; grayish brown (2.5Y 5/2) silty clay, light brownish gray (2.5Y 6/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; very hard, firm; slightly acid; gradual smooth boundary.

BC—39 to 48 inches; grayish brown (2.5Y 5/2) silty clay, light brownish gray (2.5Y 6/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; very hard, firm; neutral; gradual smooth boundary.

C—48 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (2.5Y 7/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; massive; hard, firm; few small pipelike iron concretions; few hard lime concretions; neutral.

The solum ranges from 36 to 50 inches in thickness. The mollic epipedon ranges from 12 to 18 inches in thickness. Carbonates are generally absent, but some pedons have a few hard concretions between depths of 30 and 50 inches.

The A horizon has color value of 2 or 3 (3 or 4 dry) and chroma of 1 or 2. Reaction is medium acid or slightly acid. The Bt horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. It is silty clay averaging between 42 and 50 percent clay. Reaction is medium acid to neutral. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6 (6 or 7 dry), and chroma of 1 or 2.

In map units WtC2 and WtD2, the solum is thinner and the A horizon is lighter in color and thinner than is defined for the Wymore series. These differences, however, do not affect the use or behavior of the soils.

Zook Series

The Zook series consists of deep, poorly drained soils on bottom lands. Permeability is slow. These soils formed in alluvium along streams. Slope is 0 to 1 percent.

Zook soils are near Colo, Judson, Nodaway, and Sharpsburg soils. Colo, Judson, and Nodaway soils have less clay in the control section (10 to 40 inches). Judson, Nodaway, and Sharpsburg soils are better drained. Sharpsburg soils are at higher positions.

Typical pedon of Zook silty clay loam, 0 to 2 percent slopes, 1,400 feet west and 2,320 feet north of the southeast corner of sec. 29, T. 12 N., R. 9 E.

Ap—0 to 6 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; hard, friable; slightly acid; abrupt smooth boundary.

A1—6 to 12 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; hard, firm; medium acid; clear smooth boundary.

A2—12 to 20 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; strong fine subangular blocky structure; hard, firm; very dark gray (10YR 3/1) streaks; medium acid; gradual smooth boundary.

A3—20 to 32 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; very hard, very firm; black (10YR 2/1) coatings on faces of peds; medium acid; gradual smooth boundary.

Bg—32 to 44 inches; dark gray (5Y 4/1) and very dark gray (10YR 3/1) silty clay, gray (5Y 5/1 and 10YR 5/1) dry; weak medium subangular blocky structure; very hard, very firm; medium acid; gradual smooth boundary.

Cg—44 to 60 inches; very dark gray (5Y 3/1) silty clay, dark gray (5Y 4/1) and gray (5Y 5/1) dry; massive; very hard, very firm; medium acid.

The solum ranges from 36 to 60 inches in thickness. Reaction is medium acid or slightly acid throughout the profile.

The A horizon has color value of 2 or 3 (3 to 5 dry) and chroma of 1 or 2. It is dominantly silty clay loam and silty clay but in places is silt loam. The B horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1. It is silty clay loam or silty clay and averages between 38 and 46 percent clay. If present, the C horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 5 (4 to 6 dry), and chroma of 1. In some pedons, there are faint mottles of high chroma and value below a depth of 36 inches.

Formation of the Soils

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

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

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

Parent Material

Parent material is the earthy material in which a soil forms. It is largely responsible for the mineralogical composition of the soil. In Cass County the soils formed in nine kinds of parent material: limestone residuum, sandstone residuum, glacial till, glacial outwash, eolian sand, Loveland Loess, Peorian Loess, colluvium, and alluvium.

Only a small acreage of soil has formed in limestone and sandstone residuum because bedrock generally is deeply covered. Hedville soils formed in strong brown or reddish, sandy material weathered from sandstone. Sogn soils formed in silty material weathered from limestone. These soils are shallow because the solid rock is resistant to weathering. The dominant vegetation is grasses or stands of mixed grasses, shrubby brush, and trees.

Glacial till is a mixture of silt, sand, and clay studded with pebbles and occasional stones. It is generally grayish or brownish. Till is on uplands in the southern part of the county. In some places, these deposits contain small pockets of sand and gravel. Burchard and Pawnee soils developed in glacial till.

Areas of reddish to brownish glacial outwash (reworked till) are associated with glacial till throughout the uplands. Morrill soils formed in loamy sediment that contains much sand and a few pebbles. Mayberry soils formed in clayey sediment that contains sand and pebbles.

Eolian sand was deposited in a small area on the south side of the Platte River near the town of Louisville. Only Thurman soils formed in this material in Cass County.

Reddish brown Loveland Loess is generally exposed on side slopes and is less than 10 feet thick. It is older and more oxidized than Peorian Loess. Geary soils developed in Loveland Loess.

Peorian Loess is the most extensive of the parent materials in Cass County. This silty material is grayish, brownish, or yellowish brown and is a few feet to about 100 feet thick. Generally, this loess is yellowish brown and silty along the Platte and Missouri Rivers and becomes progressively browner, then grayer, and more clayey in the areas farthest from these two rivers. Fillmore, Ida, Marshall, Monona, Sharpsburg, and Wymore soils formed in Peorian Loess. These soils are on uplands, although a few of them are on some stream terraces.

Colluvium is on foot slopes or lower side slopes adjacent to steeper uplands and consists of recent deep sediment of friable material moved by gravity and water. It is generally brown silt loam or silty clay loam. Judson soils developed in colluvial material.

The recent alluvium of the minor valleys consists of silty and clayey sediments washed from upland slopes and deposited on flood plains. Colo, Kennebec, Nodaway, and Zook soils formed in recent alluvium. In many places, these soils are frequently or occasionally flooded and fresh deposits continue to accumulate.

The recent alluvium of the major valleys consists of sandy, silty, and clayey sediments carried from upstream and deposited on wide flood plains. In lower lying areas adjacent to these rivers, these soils may be flooded several times a year. Areas farther away and on higher positions may be inundated only during major floods. Nodaway and Sarpy soils formed in alluvium along the

Platte River, and Albaton, Haynie, Onawa, and Sarpy soils formed in alluvium along the Missouri River.

Climate

Climate is an active factor in the formation of soils. Its influence is both direct and indirect. In the past cold temperatures activated glaciers that left till, and dry and windy periods produced eolian sand or dust particles that accumulated as loess. At present, the movement of water received as rain influences the shape of the landscape, and alternate freezing and thawing of the soil hastens disintegration of parent material. Indirectly, climate affects the soils because it influences the amount and kind of vegetation and animal life.

The continental climate of Cass County has seasonal variations. The average temperature is about 51 degrees F, and the annual precipitation is about 32 inches. Winter is moderately long and cold, and temperatures are commonly below 0 degree F. Spring is cool and has considerable precipitation. Summer is warm and temperatures are often higher than 95 degrees F. Thunderstorms are common during late spring and summer. Fall is mild and has occasional periods of rain.

Enough precipitation enters the soil and moves through it to carry carbonates and other soluble elements to a depth of at least 2 feet in most soils. Except for some of the steeper soils and soils on bottom lands, most of the soils in Cass County are strongly acid to slightly acid in the surface layer. Some of the steeper soils have carbonates at or near the surface because either the soil has been eroded to that depth or the steepness does not allow water to soak in and leach the soluble elements.

Plant and Animal Life

Grass, trees, animals, micro-organisms, earthworms, man, and other forms of life on or in the soil are active in soil formation. The kinds of plants and animals present are determined by environmental factors, such as climate, parent material, age of the soil, relief, and drainage.

Before the soils were cultivated, the dominant vegetation in Cass County was mid and tall grasses. This kind of vegetation provides an abundance or organic matter that affects the physical and chemical properties of the soil and darkens the surface layer. The fibrous roots of these grasses penetrate the soil, make it porous, and encourage development of granular structure. The plant roots take up minerals in solution from the lower parts of the soil and eventually return them to the surface. Along the Platte and Missouri Rivers and Weeping Water Creek, much of the area still has oak forests with a mixture of hickory and cedar. When these trees die and decay, they provide a more acid environment than is normal in the county.

Micro-organisms, insects, earthworms, and burrowing rodents are beneficial to the soil structure and make the soil more fertile and productive. Micro-organisms convert organic remains into humus from which living plants obtain nutrients. Small burrowing rodents, earthworms, and insects make openings and channels in the soil and aerate, loosen, and mix it. Their remains add to the organic matter.

Relief

Relief, or lay of the land, influences the formation of soil by affecting runoff, erosion, and drainage. Runoff is more rapid on steep and very steep soils than on more gently sloping soils. Less water penetrates the soil on areas that have rapid runoff, and less water means less vegetation. Also, rapidly moving water can remove the soil almost as fast as it forms.

Soils in slightly depressional areas, such as the Fillmore soils, collect water and have characteristics that result from deep percolation of additional moisture. Clay colloids are leached away, leaving a grayish subsurface layer, and are then deposited lower in the profile to form a dark, clayey subsoil. These claypan soils have very slow permeability

Some of the nearly level soils on bottom lands are somewhat poorly drained or poorly drained because they have slow runoff or a moderately high water table.

Time

The passage of time enables relief, climate, and plants and animals to bring about the changes in parent material that result in the formation of a soil. The longer the parent material is exposed to soil development, the more nearly the soil reaches a balance with its environment.

If the parent material has been in place only a short time, the soils are weakly developed because climate and vegetation have not been acting on the material for very long. Kennebec and Nodaway soils are weakly developed. They formed in recent alluvial deposits during the last few centuries. Some of these soils have formed only during the last few years.

Generally, soils have to be in place for some time to develop genetic profiles and thick horizons. Fillmore, Sharpsburg, and Wymore soils developed in Peorian Loess and have been in place long enough to have formed well defined, genetically related horizons. Pawnee soils, which formed in glacial till, also have well defined, genetically related horizons. However, because Pawnee soils have been developing for less time than the soils that formed in Peorian Loess, they are less deeply leached of carbonates.

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

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.

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

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

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.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

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 fragments. Mineral or rock particles larger than 2 millimeters in diameter.

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.

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. Tillage that does not invert the soil and that 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.
Cemented.—Hard; little affected by moistening.

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.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Depth, soil. The total thickness of the soil over bedrock. In this survey the classes of soil depth are *very shallow* (less than 10 inches), *shallow* (10 to 20 inches), *moderately deep* (20 to 40 inches), and *deep* (more than 40 inches).

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 frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:
Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.
Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.
Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

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 is not a source of gravel or sand for construction purposes.

Excess lime (in tables). Excess carbonates in the soil restricts the growth of some plants.

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.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

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.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

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.

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.

Habitat. The kind of environment in which a plant or animal normally lives, as opposed to the range or geographic distribution.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon. —The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizons. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but can be directly below an A or a B horizon.

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.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

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

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

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

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.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

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.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay 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. Plant and animal residue in the soil in various stages of decomposition. The classes used in this survey are *low* (0.5 to 1.0 percent), *moderately low* (1.0 to 2.0 percent), *moderate* (2.0 to 4.0 percent), and *high* (4.0 to 8.0 percent).

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

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

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

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. Unless the soils are artificially drained, 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 the soil may not adequately filter effluent from a waste disposal system.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

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.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

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.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

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.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

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.

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
Very gently sloping	1 to 4
Gently sloping	2 to 5
Strongly sloping	5 to 11
Moderately steep	11 to 17
Steep	17 to 30
Very steep	more than 30

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 millimeters 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, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stratified. Arranged in strata, or layers. The term refers to layers in the soil inherited from parent material. Layers resulting from soil formation are called "horizons."

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 solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

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."

Surface soil. The part of the soil above the subsoil, including the A, E, AB, and EB horizons. Includes all subdivisions of these horizons.

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."

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.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, that are in soils in extremely small amounts. They are essential to plant growth.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

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.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-78 at Weeping Water, Nebraska]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days[1]	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F		In	In	In		In
January----	32.4	10.3	21.4	59	-19	0	0.81	0.28	1.24	3	7.7
February---	40.0	17.5	28.7	69	-15	10	1.15	.29	1.83	3	6.5
March------	48.9	26.3	37.7	80	-4	43	2.04	.59	3.21	5	6.1
April------	65.2	39.5	52.4	88	17	141	2.90	1.44	4.17	6	.6
May--------	75.7	50.4	63.1	94	29	413	4.44	2.58	6.09	8	.1
June-------	84.9	60.2	72.7	101	42	681	4.08	1.71	6.08	7	.0
July-------	89.4	65.0	77.2	103	49	843	3.83	1.35	5.87	6	.0
August-----	87.0	62.7	74.9	101	46	772	4.43	1.80	6.63	7	.0
September--	78.4	53.2	65.8	98	32	474	3.75	1.48	5.65	6	.0
October----	68.3	41.6	55.0	89	21	202	2.30	.53	3.70	4	.1
November---	51.0	28.1	39.6	75	3	14	1.36	.29	2.20	3	2.3
December---	38.2	16.6	27.4	64	-13	0	.87	.34	1.30	3	5.6
Year-----	63.3	39.3	51.3	---	---	3,593	31.96	24.42	39.17	61	29.0

[1]A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951-78 at Weeping Water, Nebraska]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 21	April 29	May 13
2 years in 10 later than--	April 16	April 24	May 7
5 years in 10 later than--	April 7	April 15	April 28
First freezing temperature in fall:			
1 year in 10 earlier than--	October 17	October 6	September 24
2 years in 10 earlier than--	October 22	October 11	September 28
5 years in 10 earlier than--	October 31	October 20	October 7

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-78 at Weeping Water, Nebraska]

Probability	Length of growing season if daily minimum temperature is---		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	187	168	145
8 years in 10	194	175	151
5 years in 10	206	187	161
2 years in 10	219	199	172
1 year in 10	225	205	177

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Ab	Albaton silty clay, 0 to 1 percent slopes	730	0.2
BmD	Burchard-Morrill clay loams, 6 to 11 percent slopes	350	0.1
Co	Colo silty clay loam, 0 to 2 percent slopes	5,500	1.5
Cp	Colo-Nodaway complex, 0 to 2 percent slopes	12,100	3.4
Fm	Fillmore silt loam, 0 to 1 percent slopes	880	0.2
GeD2	Geary silty clay loam, 6 to 11 percent slopes, eroded	1,400	0.4
Ha	Haynie silt loam, 0 to 2 percent slopes	2,850	0.8
HdF	Hedville sandy loam, 6 to 20 percent slopes	210	0.1
IdF	Ida silt loam, 17 to 30 percent slopes	660	0.2
Ju	Judson silt loam, 0 to 2 percent slopes	1,300	0.4
JuC	Judson silt loam, 2 to 6 percent slopes	17,400	4.8
Ke	Kennebec silt loam, 0 to 2 percent slopes	4,150	1.1
MaC	Marshall silty clay loam, 2 to 5 percent slopes	5,000	1.4
MaC2	Marshall silty clay loam, 2 to 5 percent slopes, eroded	21,000	5.8
MaD	Marshall silty clay loam, 5 to 11 percent slopes	1,250	0.3
MaD2	Marshall silty clay loam, 5 to 11 percent slopes, eroded	37,800	10.5
MaE2	Marshall silty clay loam, 11 to 17 percent slopes, eroded	3,350	0.9
MeD2	Mayberry silty clay loam, 6 to 11 percent slopes, eroded	2,500	0.7
MnC	Monona silt loam, 2 to 5 percent slopes	2,100	0.6
MnD2	Monona silt loam, 5 to 11 percent slopes, eroded	6,900	1.9
MnE2	Monona silt loam, 11 to 17 percent slopes, eroded	8,200	2.3
MnF	Monona silt loam, 17 to 30 percent slopes	6,300	1.7
MoE2	Monona-Ida silt loams, 11 to 17 percent slopes, eroded	1,700	0.5
MoG	Monona-Ida silt loams, 30 to 60 percent slopes	500	0.1
MrD2	Morrill clay loam, 6 to 11 percent slopes, eroded	450	0.1
Nd	Nodaway silt loam, 0 to 2 percent slopes	8,900	2.5
Nh	Nodaway silt loam, channeled	16,000	4.4
On	Onawa silty clay, 0 to 2 percent slopes	2,050	0.6
PaD2	Pawnee clay loam, 6 to 11 percent slopes, eroded	1,700	0.5
Pg	Pits and dumps	1,400	0.4
Ph	Pits, Quarries	3,700	1.0
Sa	Sarpy loamy fine sand, frequently flooded	1,050	0.3
SbB	Sarpy-Haynie complex, 0 to 3 percent slopes	2,750	0.8
Sh	Sharpsburg silty clay loam, 0 to 2 percent slopes	7,500	2.1
ShC	Sharpsburg silty clay loam, 2 to 5 percent slopes	14,600	4.0
ShC2	Sharpsburg silty clay loam, 2 to 5 percent slopes, eroded	39,300	10.9
ShD	Sharpsburg silty clay loam, 5 to 9 percent slopes	1,750	0.5
ShD2	Sharpsburg silty clay loam, 5 to 9 percent slopes, eroded	63,100	17.5
ShE2	Sharpsburg silty clay loam, 9 to 15 percent slopes, eroded	4,250	1.2
Sk	Sharpsburg silty clay loam, terrace, 0 to 1 percent slopes	2,800	0.8
SkB	Sharpsburg silty clay loam, terrace, 1 to 3 percent slopes	770	0.2
SmB	Sharpsburg Variant silty clay loam, 1 to 4 percent slopes	204	0.1
SoF	Sogn-Rock outcrop complex, 11 to 30 percent slopes	1,950	0.5
ThE	Thurman loamy fine sand, 9 to 20 percent slopes	650	0.2
Ud	Udorthents, silty	110	*
Wt	Wymore silty clay loam, 0 to 2 percent slopes	4,300	1.2
WtC	Wymore silty clay loam, 2 to 5 percent slopes	4,550	1.3
WtC2	Wymore silty clay loam, 2 to 5 percent slopes, eroded	10,500	2.9
WtD2	Wymore silty clay loam, 5 to 9 percent slopes, eroded	13,500	3.7
Zo	Zook silty clay loam, 0 to 2 percent slopes	1,250	0.3
Zp	Zook silty clay, 0 to 1 percent slopes	450	0.1
	Water areas smaller than 40 acres	1,200	0.3
	Water areas larger than 40 acres	6,096	1.7
	Total	360,960	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS

[Yields are those that can be expected under a high level of management]

Soil name and map symbol	Corn	Soybeans	Grain sorghum	Winter wheat	Alfalfa hay
	Bu	Bu	Bu	Bu	Ton
Ab: Albaton	75	30	70	30	3.9
BmD: Burchard-Morrill	70	26	75	33	3.1
Co: Colo	98	40	100	39	4.9
Cp: Colo-Nodaway	75	30	80	33	4.5
Fm: Fillmore	50	25	52	22	2.5
GeD2: Geary	60	27	62	34	3.1
Ha: Haynie	100	39	100	40	5.0
Ju: Judson	110	44	110	45	5.1
JuC: Judson	106	42	104	42	4.9
Ke: Kennebec	115	45	110	45	5.2
MaC: Marshall	100	41	100	43	4.8
MaC2: Marshall	97	38	97	40	4.5
MaD: Marshall	90	37	92	40	4.1
MaD2: Marshall	85	34	87	38	4.0
MaE2: Marshall	72	30	75	34	3.3
MeD2: Mayberry	55	22	60	35	3.0
MnC: Monona	98	39	97	40	4.5
MnD2: Monona	85	34	86	36	4.0
MnE2: Monona	69	26	70	33	3.3
MoE2: Monona-Ida	65	24	65	26	2.9
MrD2: Morrill	70	26	75	34	3.2
Nd: Nodaway	104	42	105	35	5.0

TABLE 5.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Corn	Soybeans	Grain sorghum	Winter wheat	Alfalfa hay
	Bu	Bu	Bu	Bu	Ton
On: Onawa	90	34	85	39	4.0
PaD2: Pawnee	50	21	62	27	3.0
SbB: Sarpy-Haynie	60	25	60	25	3.0
Sh: Sharpsburg	98	40	98	44	4.8
ShC: Sharpsburg	93	37	95	42	4.5
ShC2: Sharpsburg	89	35	92	40	4.3
ShD: Sharpsburg	85	33	85	39	4.0
ShD2: Sharpsburg	80	32	82	37	3.7
ShE2: Sharpsburg	70	27	70	34	3.1
Sk: Sharpsburg	107	42	105	45	5.0
SkB: Sharpsburg	96	38	97	42	4.8
SmB: Sharpsburg Variant	40	21	63	27	2.8
Wt: Wymore	79	35	85	42	4.2
WtC: Wymore	77	30	80	40	3.7
WtC2: Wymore	72	27	75	37	3.5
WtD2: Wymore	60	23	65	28	3.0
Zo: Zook	96	36	90	34	4.0
Zp: Zook	92	32	85	30	3.9

TABLE 6.--CAPABILITY CLASSES AND SUBCLASSES

[Miscellaneous areas are excluded. Absence of an entry indicates no acreage]

Class	Total acreage	Major management concerns (Subclass)		
		Erosion (e)	Wetness (w)	Soil problem (s)
		Acres	Acres	Acres
I	15,750	---	---	---
II	125,120	100,270	20,550	4,300
III	139,910	125,750	14,160	---
IV	40,464	37,400	---	3,064
V	---	---	---	---
VI	26,820	7,610	17,050	2,160
VII	500	500	---	---
VIII	5,100	---	---	5,100

TABLE 7.--PRIME FARMLAND

[Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name]

Map symbol	Soil name
*Co	Colo silty clay loam, 0 to 2 percent slopes (where drained)
Ha	Haynie silt loam, 0 to 2 percent slopes
Ju	Judson silt loam, 0 to 2 percent slopes
JuC	Judson silt loam, 2 to 6 percent slopes
Ke	Kennebec silt loam, 0 to 2 percent slopes
MaC	Marshall silty clay loam, 2 to 5 percent slopes
MaC2	Marshall silty clay loam, 2 to 5 percent slopes, eroded
MnC	Monona silt loam, 2 to 5 percent slopes
Nd	Nodaway silt loam, 0 to 2 percent slopes
*On	Onawa silty clay, 0 to 2 percent slopes (where drained)
Sh	Sharpsburg silty clay loam, 0 to 2 percent slopes
ShC	Sharpsburg silty clay loam, 2 to 5 percent slopes
ShC2	Sharpsburg silty clay loam, 2 to 5 percent slopes, eroded
Sk	Sharpsburg silty clay loam, terrace, 0 to 1 percent slopes
SkB	Sharpsburg silty clay loam, terrace, 1 to 3 percent slopes
Wt	Wymore silty clay loam, 0 to 2 percent slopes
WtC	Wymore silty clay loam, 2 to 5 percent slopes
WtC2	Wymore silty clay loam, 2 to 5 percent slopes, eroded
*Zo	Zook silty clay loam, 0 to 2 percent slopes (where drained)
*Zp	Zook silty clay, 0 to 1 percent slopes (where drained)

* The soil generally has been adequately drained, either artificially or through incidental drainage resulting from farming operations, road building, or other kinds of land development.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
Ab------ Albaton	Blackhaw------	Siberian peashrub, Tatarian honeysuckle.	Osageorange, Russian-olive, eastern redcedar, Washington hawthorn.	Hackberry, bur oak, honeylocust, green ash.	Eastern cottonwood.
BmD*:					
Burchard------	Peking cotoneaster	Tatarian honeysuckle, lilac, American plum.	Eastern redcedar, Russian mulberry, green ash, hackberry, bur oak.	Austrian pine, Scotch pine, honeylocust.	---
Morrill------	Peking cotoneaster	Amur honeysuckle, lilac, fragrant sumac.	Green ash, hackberry, Russian-olive, eastern redcedar, bur oak.	Austrian pine, honeylocust, Scotch pine.	---
Co------ Colo	Lilac------	Siberian peashrub, Tatarian honeysuckle.	Eastern redcedar, blue spruce, hackberry, ponderosa pine.	Silver maple, golden willow, honeylocust, green ash.	Eastern cottonwood.
Cp*:					
Colo------	Lilac------	Siberian peashrub, Tatarian honeysuckle.	Eastern redcedar, blue spruce, hackberry, ponderosa pine.	Silver maple, golden willow, honeylocust, green ash.	Eastern cottonwood.
Nodaway------	---	Amur honeysuckle, autumn-olive, Amur maple, lilac.	Eastern redcedar	Austrian pine, hackberry, honeylocust, green ash, eastern white pine, pin oak.	Eastern cottonwood.
Fm------ Fillmore	Redosier dogwood	Common chokecherry, American plum.	Eastern redcedar, hackberry.	Austrian pine, green ash, honeylocust, silver maple, northern red oak, golden willow.	Eastern cottonwood.
GeD2------ Geary	Lilac, fragrant sumac, Amur honeysuckle.	Russian mulberry	Eastern redcedar, hackberry, bur oak, green ash, Russian-olive, Austrian pine, honeylocust.	Siberian elm------	---
Ha------ Haynie	Blackhaw------	Tatarian honeysuckle, Siberian peashrub.	Russian-olive, osageorange, eastern redcedar, Washington hawthorn.	Green ash, hackberry, honeylocust, bur oak.	Eastern cottonwood.
HdF. Hedville					
IdF------ Ida	Fragment sumac, Tatarian honey-suckle.	Siberan peashrub	Honeylocust, eastern redcedar, green ash, Russian-olive, bur oak, osage-orange, northern catalpa, black locust.	Siberian elm------	---

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
Ju----------------- Judson	---	Amur honeysuckle, lilac, autumn-olive, Amur maple.	Eastern redcedar	Austrian pine, eastern white pine, honeylocust hackberry, green ash, pin oak.	Eastern cottonwood.
JuC--------------- Judson	Peking cotoneaster, lilac.	Skunkbush sumac, Amur honeysuckle.	Bur oak, hackberry, eastern redcedar, Russian mulberry, green ash.	Austrian pine, honeylocust, Scotch pine.	---
Ke----------------- Kennebec	---	Amur maple, Amur honeysuckle, lilac, autumn-olive.	Eastern redcedar	Austrian pine, hackberry, pin oak, green ash, honeylocust, eastern white pine.	Eastern cottonwood.
MaC, MaC2, MaD, MaD2, MaE2-------- Marshall	---	Autumn-olive, lilac, Amur maple, Amur honeysuckle.	Eastern redcedar, Russian-olive, hackberry, bur oak, green ash.	Austrian pine, eastern white pine, honeylocust.	---
MeD2-------------- Mayberry	Siberian peashrub, Amur honeysuckle, lilac, Peking cotoneaster.	Eastern redcedar, Manchurian crabapple.	Russian-olive, Austrian pine, green ash, hackberry, honeylocust.	Siberian elm------	---
MnC, MnD2, MnE2--- Monona	Peking cotoneaster, lilac.	Skunkbush sumac, Amur honeysuckle.	Bur oak, hackberry, green ash, Russian mulberry, eastern redcedar.	Honeylocust, Scotch pine, Austrian pine.	---
MnF. Monona					
MoE2*: Monona------------	Peking cotoneaster, lilac.	Skunkbush sumac, Amur honeysuckle.	Bur oak, hackberry, green ash, Russian mulberry, eastern redcedar.	Honeylocust, Scotch pine, Austrian pine.	---
Ida----------------	Fragrant sumac, Tatarian honeysuckle.	Siberian peashrub	Honeylocust, bur oak, osageorange, eastern redcedar, green ash, Russian-olive, northern catalpa, black locust.	Siberian elm------	---
MoG*: Monona.					
Ida.					
MrD2-------------- Morrill	Peking cotoneaster	Amur honeysuckle, lilac, fragrant sumac.	Green ash, hackberry, Russian-olive, eastern redcedar, bur oak.	Austrian pine, honeylocust, Scotch pine.	---
Nd----------------- Nodaway	---	Amur honeysuckle, autumn-olive, Amur maple, lilac.	Eastern redcedar	Austrian pine, hackberry, honeylocust, green ash, eastern white pine, pin oak.	Eastern cottonwood.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
Nh. Nodaway					
On. Onawa	---	American plum, common chokecherry, fragrant sumac.	Eastern redcedar, hackberry, Manchurian crabapple.	Austrian pine, honeylocust, green ash, golden willow, Russian mulberry.	Eastern cottonwood.
PaD2. Pawnee	Amur honeysuckle, lilac, Siberian peashrub, Peking cotoneaster.	Eastern redcedar, Manchurian crabapple.	Austrian pine, Russian-olive, green ash, hackberry, honeylocust.	Siberian elm	---
Pg*. Pits and dumps					
Ph*. Pits					
Sa. Sarpy					
SbB*: Sarpy	Blackhaw	Tatarian honeysuckle, Siberian peashrub.	Washington hawthorn, Russian-olive, eastern redcedar, osageorange.	Hackberry, green ash, honeylocust, bur oak, Austrian pine.	---
Haynie	Blackhaw	Tatarian honeysuckle, Siberian peashrub.	Russian-olive, osageorange, eastern redcedar, Washington hawthorn.	Green ash, hackberry, honeylocust, bur oak.	Eastern cottonwood.
Sh, ShC, ShC2, ShD, ShD2, ShE2, Sk, SkB. Sharpsburg	---	Amur maple, Amur honeysuckle, lilac, autumn-olive.	Green ash, hackberry, bur oak, eastern redcedar, Russian-olive.	Austrian pine, eastern white pine, honeylocust.	---
SmB. Sharpsburg Variant	Silver buffaloberry, Siberian peashrub, lilac, Tatarian honeysuckle.	Siberian elm, eastern redcedar, green ash, ponderosa pine, Russian-olive.	---	---	---
SoF*: Sogn.					
Rock outcrop.					
ThE. Thurman	---	Eastern redcedar, Rocky Mountain juniper.	Austrian pine, ponderosa pine, jack pine, Scotch pine.	---	---
Ud. Udorthents					
Wt, WtC, WtC2, WtD2. Wymore	Peking cotoneaster, skunkbush sumac, lilac.	Manchurian crabapple, Amur honeysuckle.	Eastern redcedar, Austrian pine, ponderosa pine, Russian-olive, hackberry, green ash.	Honeylocust	---

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
Zo, Zp------------- Zook	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Honeylocust, golden willow, green ash, northern red oak, silver maple, Austrian pine.	Eastern cottonwood.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
Ab: Albaton	Severe: flooding, wetness, percs slowly.	Severe: too clayey, percs slowly.	Severe: too clayey, wetness, percs slowly.	Severe: too clayey.	Severe: too clayey.
BmD*:					
Burchard	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
Morrill	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Co: Colo	Severe: flooding.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight	Moderate: flooding.
Cp*:					
Colo	Severe: flooding, wetness.	Moderate: flooding, wetness, percs slowly.	Severe: wetness, flooding.	Moderate: flooding, wetness.	Severe: flooding.
Nodaway	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
Fm: Fillmore	Severe: ponding, percs slowly.	Severe: ponding, percs slowly.	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.
GeD2: Geary	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Ha: Haynie	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
HdF: Hedville	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, small stones.	Slight	Severe: thin layer.
IdF: Ida	Severe: slope.	Severe: slope.	Severe: slope.	Severe: erodes easily.	Severe: slope.
Ju: Judson	Slight	Slight	Slight	Slight	Slight.
JuC: Judson	Slight	Slight	Moderate: slope.	Slight	Slight.
Ke: Kennebec	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
MaC, MaC2: Marshall	Slight	Slight	Moderate: slope.	Slight	Slight.
MaD, MaD2, MaE2: Marshall	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
MeD2: Mayberry	Severe: wetness.	Moderate: slope, wetness.	Severe: slope, wetness.	Severe: erodes easily.	Moderate: wetness, slope.
MnC: Monona	Slight	Slight	Moderate: slope.	Slight	Slight.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
MnD2, MnE2: Monona	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
MnF: Monona	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
MoE2*:					
Monona	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Ida	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.	Moderate: slope.
MoG*:					
Monona	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Ida	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, erodes easily.	Severe: slope.
MrD2: Morrill	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
Nd: Nodaway	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
Nh: Nodaway	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
On: Onawa	Severe: flooding, too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.
PaD2: Pawnee	Severe: wetness.	Moderate: slope, wetness.	Severe: slope, wetness.	Severe: erodes easily.	Moderate: slope, wetness.
Pg*. Pits and dumps					
Ph*. Pits					
Sa: Sarpy	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
SbB*:					
Sarpy	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: droughty, flooding.
Haynie	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
Sh: Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: percs slowly.	Slight	Slight.
ShC, ShC2: Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Slight.
ShD, ShD2: Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight	Slight.
ShE2: Sharpsburg	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
Sk: Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: percs slowly.	Slight	Slight.
SkB: Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Slight.
SmB: Sharpsburg Variant	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Slight.
SoF*:					
Sogn	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Moderate: slope.	Severe: slope, thin layer.
Rock outcrop.					
ThE: Thurman	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty.
Ud. Udorthents					
Wt, WtC, WtC2: Wymore	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Severe: erodes easily.	Moderate: wetness.
WtD2: Wymore	Severe: wetness.	Moderate: wetness.	Severe: slope, wetness.	Severe: erodes easily.	Moderate: wetness.
Zo: Zook	Severe: wetness, flooding.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
Zp: Zook	Severe: wetness, flooding, too clayey.	Severe: too clayey.	Severe: too clayey, wetness.	Severe: too clayey.	Severe: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
Ab Albaton	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
BmD*:										
Burchard	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Morrill	Fair	Good	Good	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.
Co Colo	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
Cp*:										
Colo	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
Nodaway	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Fair	Fair.
Fm Fillmore	Fair	Good	Fair	Fair	Fair	Good	Fair	Fair	Fair	Fair.
GeD2 Geary	Fair	Good	Good	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.
Ha Haynie	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
HdF Hedville	Very poor.	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
IdF Ida	Poor	Fair	Good	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
Ju, JuC Judson	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Ke Kennebec	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
MaC, MaC2 Marshall	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
MaD, MaD2, MaE2 Marshall	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
MeD2 Mayberry	Fair	Good	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
MnC Monona	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
MnD2 Monona	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
MnE2 Monona	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
MnF Monona	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
MoE2*:										
Monona	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Ida	Fair	Good	Good	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.
MoG*:										
Monona	Very poor.	Very poor.	Good	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.
Ida	Very poor.	Very poor.	Good	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
MrD2 Morrill	Fair	Good	Good	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.
Nd Nodaway	Good	Good	Good	Good	Fair	Fair	Poor	Good	Good	Fair.
Nh Nodaway	Poor	Fair	Fair	Poor	Poor	Fair	Fair	Poor	Poor	Fair.
On Onawa	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
PaD2 Pawnee	Fair	Good	Good	Fair	Fair	Very poor.	Poor	Good	Fair	Very poor.
Pg*. Pits and dumps										
Ph*. Pits										
Sa Sarpy	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
SbB*:										
Sarpy	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Haynie	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Sh, ShC, ShC2 Sharpsburg	Good	Good	Good	Good	Good	Very poor.	Poor	Good	Good	Very poor.
ShD, ShD2, ShE2 Sharpsburg	Fair	Good	Good	Good	Good	Very poor.	Poor	Good	Good	Very poor.
Sk, SkB Sharpsburg	Good	Good	Good	Good	Good	Very poor.	Poor	Good	Good	Very poor.
SmB Sharpsburg Variant	Fair	Fair	Poor	Fair	Fair	Very poor.	Poor	Fair	Fair	Very poor.
SoF*:										
Sogn	Very poor.	Very poor.	Poor	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.
Rock outcrop.										
ThE Thurman	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Ud. Udorthents										

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
Wt------------------ Wymore	Good	Good	Fair	Good	Good	Poor	Very poor.	Good	Good	Very poor.
WtC, WtC2, WtD2---- Wymore	Fair	Good	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Zo, Zp-------------- Zook	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
Ab: Albaton	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, shrink-swell.	Severe: too clayey.
BmD*:						
Burchard	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
Morrill	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
Co: Colo	Severe: wetness.	Severe: flooding, shrink-swell.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell.	Severe: flooding, low strength, frost action.	Moderate: flooding.
Cp*:						
Colo	Severe: wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, low strength, frost action.	Severe: flooding.
Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Severe: flooding.
Fm: Fillmore	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, low strength, frost action.	Severe: ponding.
GeD2: Geary	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
Ha: Haynie	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.	Moderate: flooding.
HdF: Hedville	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.	Severe: thin layer.
IdF: Ida	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, frost action, low strength.	Severe: slope.
Ju: Judson	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
JuC: Judson	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
Ke: Kennebec	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
MaC, MaC2--------- Marshall	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
MaD, MaD2, MaE2--- Marshall	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
MeD2-------------- Mayberry	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell, slope.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness, slope.
MnC--------------- Monona	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
MnD2, MnE2-------- Monona	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
MnF--------------- Monona	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope, frost action.	Severe: slope.
MoE2*:						
Monona-----------	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
Ida--------------	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: frost action.	Moderate: slope.
MoG*:						
Monona-----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope, frost action.	Severe: slope.
Ida--------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, frost action.	Severe: slope.
MrD2-------------- Morrill	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
Nd---------------- Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.
Nh---------------- Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Severe: flooding.
On---------------- Onawa	Severe: wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, low strength, frost action.	Severe: too clayey.
PaD2-------------- Pawnee	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, slope, wetness.	Severe: low strength, frost action, shrink-swell.	Moderate: slope, wetness.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
Pg*. Pits and dumps						
Ph*. Pits						
Sa---------------- Sarpy	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
SbB*:						
Sarpy------------	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: droughty, flooding.
Haynie-----------	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.	Moderate: flooding.
Sh, ShC, ShC2----- Sharpsburg	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
ShD, ShD2--------- Sharpsburg	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
ShE2-------------- Sharpsburg	Moderate: too clayey, slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
Sk, SkB----------- Sharpsburg	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
SmB--------------- Sharpsburg Variant	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, frost action, shrink-swell.	Slight.
SoF*:						
Sogn-------------	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope, thin layer.
Rock outcrop.						
ThE--------------- Thurman	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty.
Ud. Udorthents						
Wt, WtC, WtC2, WtD2------------- Wymore	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action.	Moderate: wetness.
Zo---------------- Zook	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
Zp---------------- Zook	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, low strength, frost action.	Severe: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ab: Albaton	Severe: flooding, wetness, percs slowly.	Severe: wetness.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
BmD*:					
Burchard	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Morrill	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Co: Colo	Severe: wetness, flooding, percs slowly.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness, hard to pack.
Cp*:					
Colo	Severe: wetness, flooding, percs slowly.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness, hard to pack.
Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
Fm: Fillmore	Severe: percs slowly, ponding.	Severe: ponding.	Severe: too clayey, ponding.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
GeD2: Geary	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Ha: Haynie	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Good.
HdF: Hedville	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim, small stones.
IdF: Ida	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Ju: Judson	Slight	Moderate: seepage.	Slight	Slight	Good.
JuC: Judson	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Ke: Kennebec	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
MaC, MaC2: Marshall	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
MaD, MaD2, MaE2: Marshall	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
MeD2----------------- Mayberry	Severe: wetness, percs slowly.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
MnC------------------ Monona	Slight------------	Moderate: seepage, slope.	Slight------------	Slight------------	Good.
MnD2, MnE2----------- Monona	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
MnF------------------ Monona	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
MoE2*:					
Monona--------------	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Ida-----------------	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
MoG*:					
Monona--------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Ida-----------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
MrD2----------------- Morrill	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Nd, Nh--------------- Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
On------------------- Onawa	Severe: wetness, flooding.	Severe: wetness, seepage, flooding.	Severe: flooding, seepage, wetness.	Severe: wetness, flooding, seepage.	Fair: wetness.
PaD2----------------- Pawnee	Severe: percs slowly, wetness.	Severe: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Pg*. Pits and dumps					
Ph*. Pits					
Sa------------------- Sarpy	Severe: flooding, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage, too sandy.	Severe: flooding, seepage.	Poor: seepage, too sandy.
SbB*:					
Sarpy---------------	Severe: flooding, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage, too sandy.	Severe: flooding, seepage.	Poor: seepage, too sandy.
Haynie--------------	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Good.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Sh----------------- Sharpsburg	Moderate: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
ShC, ShC2----------- Sharpsburg	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
ShD, ShD2----------- Sharpsburg	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
ShE2---------------- Sharpsburg	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Sk----------------- Sharpsburg	Moderate: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
SkB---------------- Sharpsburg	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
SmB---------------- Sharpsburg Variant	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight-----------	Poor: too clayey, hard to pack.
SoF*:					
Sogn---------------	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, slope.
Rock outcrop.					
ThE---------------- Thurman	Severe: poor filter.	Severe: seepage, slope.	Severe: too sandy, seepage.	Severe: seepage.	Poor: too sandy, seepage.
Ud. Udorthents					
Wt----------------- Wymore	Severe: wetness, percs slowly.	Slight-----------	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
WtC, WtC2----------- Wymore	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
WtD2---------------- Wymore	Severe: wetness, percs slowly.	Severe: slope.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
Zo, Zp-------------- Zook	Severe: percs slowly, wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, too clayey, flooding.	Severe: wetness, flooding.	Poor: too clayey, wetness, hard to pack.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ab: Albaton	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
BmD*:				
Burchard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
Morrill	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Co: Colo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Cp*:				
Colo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Nodaway	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Fm: Fillmore	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, thin layer.
GeD2: Geary	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
Ha: Haynie	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
HdF: Hedville	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
IdF: Ida	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Ju, JuC: Judson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ke: Kennebec	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
MaC, MaC2: Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
MaD, MaD2, MaE2: Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
MeD2: Mayberry	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
MnC: Monona	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
MnD2, MnE2: Monona	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
MnF: Monona	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
MoE2*:				
Monona	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Ida	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
MoG*:				
Monona	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Ida	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
MrD2: Morrill	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Nd, Nh: Nodaway	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
On: Onawa	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
PaD2: Pawnee	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, slope.
Pg*. Pits and dumps				
Ph*. Pits				
Sa: Sarpy	Good	Probable	Improbable: too sandy.	Fair: too sandy.
SbB*:				
Sarpy	Good	Probable	Improbable: too sandy.	Fair: too sandy.
Haynie	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Sh, ShC, ShC2, ShD, ShD2, ShE2, Sk, SkB: Sharpsburg	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
SmB: Sharpsburg Variant	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salts.
SoF*:				
Sogn	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, slope.
Rock outcrop.				
ThE: Thurman	Good	Probable	Improbable: too sandy.	Poor: area reclaim.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ud. Udorthents				
Wt, WtC, WtC2, WtD2---Wymore	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Zo---Zook	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Zp---Zook	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Ab------ Albaton	Slight------	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness, slow intake, percs slowly.	Not needed-----	Not needed.
BmD*:						
Burchard------	Severe: slope.	Slight------	Deep to water	Slope------	Slope------	Slope.
Morrill------	Severe: slope.	Severe: thin layer.	Deep to water	Slope------	Slope------	Slope.
Co------ Colo	Slight------	Severe: wetness.	Flooding, frost action.	Flooding, wetness.	Wetness------	Wetness.
Cp*:						
Colo------	Slight------	Moderate: wetness.	Flooding, frost action.	Flooding, wetness.	Wetness------	Wetness.
Nodaway------	Moderate: seepage.	Severe: piping.	Deep to water	Flooding------	Erodes easily	Erodes easily.
Fm------ Fillmore	Moderate: seepage.	Severe: hard to pack, ponding.	Percs slowly, frost action, ponding.	Percs slowly, ponding, erodes easily.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
GeD2------ Geary	Severe: slope.	Slight------	Deep to water	Slope------	Slope, erodes easily.	Slope, erodes easily.
Ha------ Haynie	Moderate: seepage.	Severe: piping.	Deep to water	Flooding------	Erodes easily	Erodes easily.
HdF------ Hedville	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
IdF------ Ida	Severe: slope.	Severe: piping.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
Ju------ Judson	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
JuC------ Judson	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope------	Erodes easily	Erodes easily.
Ke------ Kennebec	Moderate: seepage.	Moderate: thin layer, piping, wetness.	Deep to water	Flooding------	Favorable------	Favorable.
MaC, MaC2------ Marshall	Moderate: seepage, slope.	Slight------	Deep to water	Slope------	Erodes easily	Erodes easily.
MaD, MaD2, MaE2--- Marshall	Severe: slope.	Slight------	Deep to water	Slope------	Erodes easily, slope.	Slope, erodes easily.
MeD2------ Mayberry	Severe: slope.	Moderate: hard to pack, wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly.	Slope, erodes easily, wetness.	Wetness, slope, erodes easily.
MnC------ Monona	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope------	Erodes easily	Erodes easily.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
MnD2, MnE2, MnF--- Monona	Severe: slope.	Moderate: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
MoE2*, MoG*:						
Monona-----------	Severe: slope.	Moderate: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
Ida--------------	Severe: slope.	Severe: piping.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
MrD2-------------- Morrill	Severe: slope.	Severe: thin layer.	Deep to water	Slope----------	Slope----------	Slope.
Nd, Nh------------ Nodaway	Moderate: seepage.	Severe: piping.	Deep to water	Flooding-------	Erodes easily	Erodes easily.
On---------------- Onawa	Severe: seepage.	Severe: piping.	Flooding, frost action.	Wetness, slow intake, percs slowly.	Not needed-----	Not needed.
PaD2-------------- Pawnee	Severe: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Percs slowly, erodes easily.	Slope, erodes easily, percs slowly.	Slope, erodes easily.
Pg*. Pits and dumps						
Ph*. Pits						
Sa---------------- Sarpy	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
SbB*:						
Sarpy------------	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
Haynie-----------	Moderate: seepage.	Severe: piping.	Deep to water	Flooding-------	Erodes easily	Erodes easily.
Sh---------------- Sharpsburg	Moderate: seepage.	Slight---------	Deep to water	Favorable------	Erodes easily	Erodes easily.
ShC, ShC2, ShD, ShD2-------------- Sharpsburg	Moderate: seepage, slope.	Slight---------	Deep to water	Slope----------	Erodes easily	Erodes easily.
ShE2-------------- Sharpsburg	Severe: slope.	Slight---------	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
Sk, SkB----------- Sharpsburg	Moderate: seepage.	Slight---------	Deep to water	Favorable------	Erodes easily	Erodes easily.
SmB--------------- Sharpsburg Variant	Slight---------	Moderate: hard to pack.	Deep to water	Percs slowly, excess salt.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
SoF*:						
Sogn-------------	Severe: depth to rock, slope.	Slight---------	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Rock outcrop.						
ThE--------------- Thurman	Severe: slope, seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Droughty, slope.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Ud. Udorthents						
Wt----------------- Wymore	Slight---------	Moderate: hard to pack, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
WtC, WtC2, WtD2--- Wymore	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
Zo----------------- Zook	Slight---------	Severe: hard to pack, wetness.	Flooding, percs slowly, frost action.	Wetness, percs slowly.	Not needed-----	Not needed.
Zp----------------- Zook	Slight---------	Severe: hard to pack, wetness.	Flooding, percs slowly, frost action.	Wetness, slow intake, percs slowly.	Not needed-----	Not needed.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Ab----------------- Albaton	0-6	Silty clay-------	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
	6-60	Silty clay, clay	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
BmD*:											
Burchard---------	0-7	Clay loam---------	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	35-50	14-24
	7-44	Clay loam---------	CL	A-6, A-7	0-5	95-100	90-100	85-95	65-80	35-50	20-30
	44-60	Clay loam---------	CL	A-6, A-7	0-5	95-100	90-100	85-95	60-80	35-50	15-30
Morrill----------	0-14	Clay loam---------	CL	A-4, A-6	0	95-100	80-100	70-100	50-75	25-35	7-15
	14-47	Clay loam, sandy clay loam.	CL, SC	A-6, A-7-6	0	90-100	70-100	60-100	35-80	30-45	11-25
	47-60	Loam, clay loam, sandy loam.	CL, ML, SM, SC	A-4, A-6, A-2	0	90-100	70-100	60-100	30-80	20-35	2-15
Co----------------- Colo	0-26	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	26-37	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	37-60	Silty clay loam	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30
Cp*:											
Colo-------------	0-24	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	24-38	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	38-60	Silty clay loam	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30
Nodaway----------	0-60	Silt loam---------	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
Fm----------------- Fillmore	0-19	Silt loam---------	ML, CL, CL-ML	A-4, A-6	0	100	100	100	95-100	20-40	2-20
	19-48	Silty clay, clay	CH, CL	A-7	0	100	100	100	95-100	40-75	20-45
	48-60	Silt loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	100	100	95-100	25-75	10-45
GeD2-------------- Geary	0-7	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	75-98	35-45	15-25
	7-46	Silty clay loam, clay loam.	CL	A-7, A-6	0	100	100	96-100	85-98	35-50	15-25
	46-60	Silty clay loam, clay loam, silt loam.	CL	A-6, A-7	0	100	100	96-100	85-98	30-45	11-22
Ha----------------- Haynie	0-7	Silt loam---------	CL-ML, CL	A-4, A-6	0	100	100	85-100	70-100	25-40	5-15
	7-60	Silt loam, very fine sandy loam.	CL-ML, CL	A-4, A-6	0	100	100	85-100	85-100	25-35	5-15
HdF---------------- Hedville	0-15	Sandy loam--------	SM, ML, SC, CL	A-4, A-6	0-15	70-100	70-100	50-85	35-70	<35	NP-13
	15	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
IdF---------------- Ida	0-60	Silt loam---------	ML, CL	A-4, A-6	0	100	100	95-100	95-100	30-40	5-15
Ju, JuC----------- Judson	0-34	Silt loam---------	CL, CL-ML	A-6, A-7, A-4	0	100	100	100	95-100	25-50	5-25
	34-60	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	30-50	15-25
Ke----------------- Kennebec	0-42	Silt loam---------	CL	A-6, A-7	0	100	100	95-100	90-100	25-45	10-20
	42-60	Silt loam, silty clay loam.	CL, CL-ML	A-6, A-4	0	100	100	95-100	90-100	25-40	5-15
MaC, MaC2, MaD, MaD2, MaE2------ Marshall	0-10	Silty clay loam	ML, CL	A-6, A-7	0	100	100	100	95-100	35-50	15-25
	10-45	Silty clay loam	ML, CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
	45-60	Silt loam, silty clay loam.	ML, CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
MeD2-------------- Mayberry	0-6	Silty clay loam	CL	A-6, A-7	0	100	95-100	90-100	75-100	35-45	15-25
	6-50	Clay, sandy clay	CL, CH	A-7	0	100	90-100	80-100	60-100	45-60	25-35
	50-60	Stratified sandy loam to clay.	CL, CH	A-6, A-7	0	95-100	95-100	85-95	70-95	35-60	15-30
MnC, MnD2, MnE2, MnF-------------- Monona	0-9	Silt loam--------	ML, CL	A-6, A-7	0	100	100	95-100	95-100	35-50	10-25
	9-28	Silt loam, silty clay loam.	ML, CL	A-6, A-7	0	100	100	95-100	95-100	35-50	10-25
	28-60	Silt loam--------	CL	A-6	0	100	100	95-100	95-100	30-40	10-20
MoE2*, MoG*: Monona----------	0-9	Silt loam--------	ML, CL	A-6, A-7	0	100	100	95-100	95-100	35-50	10-25
	9-28	Silt loam, silty clay loam.	ML, CL	A-6, A-7	0	100	100	95-100	95-100	35-50	10-25
	28-60	Silt loam--------	CL	A-6	0	100	100	95-100	95-100	30-40	10-20
Ida--------------	0-60	Silt loam--------	ML, CL	A-4, A-6	0	100	100	95-100	95-100	30-40	5-15
MrD2-------------- Morrill	0-7	Clay loam--------	CL	A-4, A-6	0	95-100	80-100	70-100	50-75	25-35	7-15
	7-45	Clay loam, sandy clay loam, gravelly clay loam.	CL, SC	A-6, A-7	0	90-100	70-100	60-100	35-80	30-45	11-25
	45-60	Loam, clay loam, sandy loam.	CL, ML, SM, SC	A-4, A-6, A-2	0	90-100	70-100	60-100	30-80	20-35	2-15
Nd, Nh----------- Nodaway	0-60	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
On--------------- Onawa	0-8	Silty clay-------	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
	8-27	Silty clay, clay	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
	27-60	Silt loam, very fine sandy loam, loam.	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
PaD2-------------- Pawnee	0-6	Clay loam--------	CL	A-6	0	95-100	95-100	85-100	70-90	30-40	10-20
	6-55	Clay-------------	CH	A-7	0	95-100	95-100	85-100	70-85	50-70	25-45
	55-60	Clay loam, sandy clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	80-100	70-90	35-55	20-40
Pg*. Pits and dumps											
Ph*. Pits											
Sa--------------- Sarpy	0-8	Loamy fine sand	SM	A-2	0	100	100	60-80	15-35	---	NP
	8-60	Fine sand, loamy fine sand, sand.	SM, SP, SP-SM	A-2, A-3	0	100	100	60-80	2-35	---	NP
SbB*: Sarpy-----------	0-6	Loamy fine sand	SM	A-2	0	100	100	60-80	15-35	---	NP
	6-60	Fine sand, loamy fine sand, sand.	SM, SP, SP-SM	A-2, A-3	0	100	100	60-80	2-35	---	NP
Haynie-----------	0-7	Very fine sandy loam.	CL-ML, CL	A-4, A-6	0	100	100	85-100	70-100	25-40	5-15
	7-60	Silt loam, very fine sandy loam.	CL-ML, CL	A-4, A-6	0	100	100	85-100	85-100	25-35	5-15

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Sh, ShC, ShC2, ShD, ShD2, ShE2, Sk, SkB-------- Sharpsburg	0-14	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	18-32
	14-45	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	40-60	20-35
	45-60	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
SmB--------------- Sharpsburg Variant	0-10	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	20-30
	10-41	Silty clay loam, silty clay.	CL, CH	A-7, A-6	0	100	100	100	95-100	35-60	20-35
	41-60	Silty clay, silty clay loam.	CL, CH	A-7, A-6	0	100	100	100	95-100	35-50	20-30
SoF*: Sogn-------------	0-10	Silty clay loam	CL, MH, CH	A-6, A-7	0-10	85-100	85-100	85-100	70-100	25-55	10-25
	10	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Rock outcrop.											
ThE--------------- Thurman	0-21	Loamy fine sand	SM, SP-SM	A-2, A-3, A-4	0	100	100	90-100	5-40	<20	NP
	21-60	Loamy fine sand, fine sand, very fine sand.	SM, SP-SM	A-2, A-3	0	100	100	85-100	5-25	---	NP
Ud. Udorthents											
Wt, WtC, WtC2, WtD2------------- Wymore	0-14	Silty clay loam	CL, CH, ML, MH	A-6, A-7	0	100	100	95-100	95-100	35-55	11-25
	14-48	Silty clay--------	CH	A-7	0	100	100	95-100	95-100	55-70	30-42
	48-60	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	85-100	35-55	20-35
Zo---------------- Zook	0-6	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	45-65	20-35
	6-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55
Zp---------------- Zook	0-21	Silty clay--------	CH	A-7	0	100	100	95-100	95-100	60-85	35-55
	21-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	G/cm^3	In/hr	In/in	pH	mmhos/cm					Pct
Ab----------------- Albaton	0-6	40-60	1.35-1.40	<0.06	0.11-0.13	7.4-8.4	<2	High-------	0.28	5	4	2-3
	6-60	50-60	1.35-1.45	<0.06	0.11-0.13	7.4-8.4	<2	High-------	0.28			
BmD*:												
Burchard---------	0-7	27-35	1.40-1.60	0.2-0.6	0.17-0.19	5.6-7.3	<2	Moderate	0.28	5	6	2-4
	7-44	27-35	1.40-1.60	0.2-0.6	0.15-0.17	6.1-8.4	<2	Moderate	0.28			
	44-60	27-35	1.40-1.60	0.2-0.6	0.14-0.16	7.4-8.4	<2	Moderate	0.28			
Morrill----------	0-14	15-29	1.30-1.40	0.6-2.0	0.14-0.21	5.1-7.3	<2	Low--------	0.28	5	6	2-3
	14-47	25-35	1.35-1.45	0.6-2.0	0.15-0.19	5.1-7.3	<2	Moderate	0.28			
	47-60	10-29	1.40-1.55	0.6-2.0	0.15-0.18	5.1-7.3	<2	Low--------	0.37			
Co----------------- Colo	0-26	27-32	1.28-1.32	0.2-0.6	0.21-0.23	5.6-7.3	<2	High-------	0.28	5	7	5-7
	26-37	30-35	1.25-1.35	0.2-0.6	0.18-0.20	6.1-7.3	<2	High-------	0.28			
	37-60	30-35	1.35-1.45	0.2-0.6	0.18-0.20	6.1-7.3	<2	High-------	0.28			
Cp*:												
Colo-------------	0-24	27-32	1.28-1.32	0.2-0.6	0.21-0.23	5.6-7.3	<2	High-------	0.28	5	7	5-7
	24-60	30-35	1.25-1.35	0.2-0.6	0.18-0.20	6.1-7.3	<2	High-------	0.28			
	38-60	30-35	1.35-1.45	0.2-0.6	0.18-0.20	6.1-7.3	<2	High-------	0.28			
Nodaway----------	0-60	18-28	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	<2	Moderate	0.37	5	6	2-3
Fm----------------- Fillmore	0-19	18-35	1.30-1.40	0.6-2.0	0.21-0.24	5.6-6.5	<2	Moderate	0.37	4	6	3-4
	19-48	40-55	1.30-1.50	<0.06	0.11-0.14	5.6-7.8	<2	High-------	0.37			
	48-60	18-45	1.30-1.50	0.06-2.0	0.10-0.22	6.6-8.4	<2	Moderate	0.37			
GeD2-------------- Geary	0-7	27-35	1.30-1.40	0.2-0.6	0.18-0.23	5.6-6.5	<2	Moderate	0.32	5	6	1-2
	7-46	27-35	1.35-1.50	0.6-2.0	0.17-0.20	5.6-7.8	<2	Moderate	0.43			
	46-60	20-35	1.30-1.40	0.6-2.0	0.15-0.19	6.1-8.4	<2	Moderate	0.43			
Ha----------------- Haynie	0-7	15-25	1.20-1.35	0.6-2.0	0.18-0.23	7.4-8.4	<2	Low--------	0.37	5	4L	2-3
	7-60	15-18	1.20-1.35	0.6-2.0	0.18-0.23	7.4-8.4	<2	Low--------	0.37			
HdF--------------- Hedville	0-15	8-22	1.35-1.50	0.6-2.0	0.14-0.20	5.6-7.3	<2	Low--------	0.32	2	3	2-3
	15	---	---	---	---	---	---	-----------	----			
IdF--------------- Ida	0-60	18-25	1.20-1.30	0.6-2.0	0.20-0.22	6.6-8.4	<2	Low--------	0.43	5	4L	5-1
Ju, JuC----------- Judson	0-34	25-32	1.30-1.35	0.6-2.0	0.21-0.23	6.1-7.3	<2	Moderate	0.28	5	7	4-5
	34-60	30-35	1.35-1.45	0.6-2.0	0.21-0.23	6.1-7.3	<2	Moderate	0.43			
Ke----------------- Kennebec	0-42	22-30	1.25-1.35	0.6-2.0	0.22-0.24	5.6-7.3	<2	Moderate	0.32	5	6	5-6
	42-60	24-28	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.43			
MaC, MaD---------- Marshall	0-10	27-35	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	<2	Moderate	0.32	5	7	2-4
	10-45	27-35	1.30-1.35	0.6-2.0	0.18-0.20	5.6-7.3	<2	Moderate	0.43			
	45-60	22-30	1.30-1.40	0.6-2.0	0.18-0.22	6.6-7.3	<2	Moderate	0.43			
MaC2, MaD2, MaE2- Marshall	0-7	27-35	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	<2	Moderate	0.32	5	7	1-2
	7-37	27-35	1.30-1.35	0.6-2.0	0.18-0.20	5.6-7.3	<2	Moderate	0.43			
	37-60	22-30	1.30-1.40	0.6-2.0	0.20-0.22	6.6-7.3	<2	Moderate	0.43			
MeD2-------------- Mayberry	0-6	27-40	1.40-1.50	0.2-0.6	0.17-0.23	5.6-6.5	<2	Moderate	0.37	4	6	1-2
	6-50	40-50	1.50-1.70	0.06-0.2	0.10-0.11	5.6-7.3	<2	High-------	0.37			
	50-60	18-45	1.40-1.50	0.06-0.2	0.09-0.16	5.6-7.3	<2	Moderate	0.37			
MnC, MnD2, MnE2, MnF-------------- Monona	0-9	20-27	1.25-1.30	0.6-2.0	0.22-0.24	5.6-7.3	<2	Moderate	0.32	5	6	1-4
	9-28	24-28	1.30-1.35	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.43			
	28-60	18-24	1.35-1.40	0.6-2.0	0.20-0.22	6.6-8.4	<2	Moderate	0.43			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	mmhos/cm					Pct
MoE2*:												
Monona----------	0-9	20-27	1.25-1.30	0.6-2.0	0.22-0.24	5.6-7.3	<2	Moderate	0.32	5	6	1-2
	9-28	24-28	1.30-1.35	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.43			
	28-60	18-24	1.35-1.40	0.6-2.0	0.20-0.22	6.6-8.4	<2	Moderate	0.43			
Ida-------------	0-60	18-25	1.20-1.30	0.6-2.0	0.20-0.22	6.6-8.4	<2	Low-------	0.43	5	4L	5-1
MoG*:												
Monona----------	0-10	20-27	1.25-1.30	0.6-2.0	0.22-0.24	5.6-7.3	<2	Moderate	0.32	5	6	3-4
	10-27	24-28	1.30-1.35	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.43			
	27-60	18-24	1.35-1.40	0.6-2.0	0.20-0.22	6.6-8.4	<2	Moderate	0.43			
Ida-------------	0-60	18-25	1.20-1.30	0.6-2.0	0.20-0.22	6.6-8.4	<2	Low-------	0.43	5	4L	5-1
MrD2------------- Morrill	0-7	15-29	1.30-1.40	0.6-2.0	0.14-0.21	5.1-7.3	<2	Low-------	0.28	5	6	1-2
	7-45	25-35	1.35-1.45	0.2-0.6	0.15-0.19	5.1-7.3	<2	Moderate	0.28			
	45-60	10-29	1.40-1.55	0.6-2.0	0.15-0.18	5.1-7.3	<2	Low-------	0.37			
Nd, Nh----------- Nodaway	0-60	18-28	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	<2	Moderate	0.37	5	6	2-3
On--------------- Onawa	0-8	38-55	1.30-1.35	0.2-0.6	0.12-0.14	7.4-8.4	<2	High------	0.32	5	4	2-3
	8-27	50-60	1.30-1.40	0.06-0.2	0.12-0.14	7.4-8.4	<2	High------	0.32			
	27-60	12-18	1.40-1.50	0.6-6.0	0.20-0.22	7.4-8.4	<2	Low-------	0.43			
PaD2------------- Pawnee	0-6	30-38	1.40-1.50	0.2-0.6	0.17-0.19	5.6-7.3	<2	Moderate	0.37	4	6	1-2
	6-55	40-50	1.50-1.70	0.06-0.2	0.09-0.11	6.1-8.4	<2	High------	0.37			
	55-60	25-35	1.40-1.50	0.06-0.2	0.14-0.16	7.4-8.4	<2	High------	0.37			
Pg*. Pits and dumps												
Ph*. Pits												
Sa--------------- Sarpy	0-8	2-5	1.20-1.50	>6.0	0.05-0.09	6.6-8.4	<2	Low-------	0.15	5	2	0.5-1.0
	8-60	2-5	1.20-1.50	>6.0	0.05-0.09	7.4-8.4	<2	Low-------	0.15			
SbB*:												
Sarpy-----------	0-6	2-5	1.20-1.50	>6.0	0.05-0.09	6.6-8.4	<2	Low-------	0.15	5	2	0.5-1.0
	6-60	2-5	1.20-1.50	>6.0	0.05-0.09	6.6-8.4	<2	Low-------	0.15			
Haynie----------	0-7	15-25	1.20-1.35	0.6-2.0	0.18-0.23	7.4-8.4	<2	Low-------	0.37	5	4L	2-3
	7-60	15-18	1.20-1.35	0.6-2.0	0.18-0.23	7.4-8.4	<2	Low-------	0.37			
Sh, ShC---------- Sharpsburg	0-14	25-27	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	<2	Moderate	0.32	5	7	3-4
	14-45	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.5	<2	Moderate	0.43			
	45-60	28-32	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	<2	Moderate	0.43			
ShC2------------- Sharpsburg	0-9	25-27	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	<2	Moderate	0.32	5	7	1-2
	9-30	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.5	<2	Moderate	0.43			
	30-60	28-32	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	<2	Moderate	0.43			
ShD-------------- Sharpsburg	0-14	25-27	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	<2	Moderate	0.32	5	7	3-4
	14-45	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.5	<2	Moderate	0.43			
	45-60	28-32	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	<2	Moderate	0.43			
ShD2, ShE2------- Sharpsburg	0-9	25-27	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	<2	Moderate	0.32	5	7	1-2
	9-30	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.5	<2	Moderate	0.43			
	30-60	28-32	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	<2	Moderate	0.43			
Sk, SkB---------- Sharpsburg	0-14	25-27	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	<2	Moderate	0.32	5	7	3-4
	14-45	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.5	<2	Moderate	0.43			
	45-60	28-32	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	<2	Moderate	0.43			
SmB-------------- Sharpsburg Variant	0-10	30-40	1.30-1.50	0.6-2.0	0.18-0.20	6.6-8.4	2-4	Moderate	0.32	5	7	1-2
	10-41	35-45	1.20-1.40	0.06-0.2	0.12-0.18	7.4-9.0	4-8	High------	0.43			
	41-60	30-45	1.30-1.50	0.2-0.6	0.18-0.20	7.4-9.0	2-4	Moderate	0.43			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	mmhos/cm					Pct
SoF*:												
Sogn-------------	0-10	27-35	1.15-1.20	0.6-2.0	0.17-0.22	6.1-8.4	<2	Moderate	0.32	1	4L	2-4
	10	---	---	---	---	---	---	----------	----			
Rock outcrop.												
ThE---------------	0-21	5-12	1.60-1.80	6.0-20	0.10-0.12	6.1-7.3	<2	Low--------	0.17	5	2	1-2
Thurman	21-60	2-10	1.60-1.80	6.0-20	0.06-0.11	6.1-7.3	<2	Low--------	0.17			
Ud. Udorthents												
Wt, WtC-----------	0-14	30-40	1.15-1.20	0.2-0.6	0.21-0.23	5.6-6.5	<2	Moderate	0.37	4	7	2-4
Wymore	14-48	42-55	1.10-1.20	0.06-0.2	0.11-0.14	5.6-7.3	<2	High-------	0.37			
	48-60	27-40	1.15-1.25	0.2-0.6	0.18-0.20	6.6-7.3	<2	High-------	0.37			
WtC2, WtD2--------	0-9	30-40	1.15-1.20	0.2-0.6	0.21-0.23	5.6-6.5	<2	Moderate	0.37	4	7	1-2
Wymore	9-29	42-55	1.10-1.20	0.06-0.2	0.11-0.14	5.6-7.3	<2	High-------	0.37			
	29-60	27-40	1.15-1.25	0.2-0.6	0.18-0.20	6.6-7.3	<2	High-------	0.37			
Zo----------------	0-6	32-38	1.30-1.35	0.2-0.6	0.21-0.23	5.6-7.3	<2	High-------	0.28	5	7	5-7
Zook	6-60	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	<2	High-------	0.28			
Zp----------------	0-21	40-44	1.35-1.40	0.06-0.2	0.11-0.13	5.6-7.3	<2	High-------	0.28	5	4	2-4
Zook	21-60	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	<2	High-------	0.28			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "occasional," "brief," "apparent," and "perched" are explained in the text. The symbol > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
Ab----------------- Albaton	D	Occasional	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	Moderate	High-----	Low.
BmD:												
Burchard----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
Morrill-----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Co----------------- Colo	B/D	Occasional	Very brief to long.	Feb-Nov	2.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
Cp:												
Colo--------------	B/D	Frequent----	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
Nodaway-----------	B	Frequent----	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Apr-Jul	>60	---	High-----	Moderate	Low.
Fm*---------------- Fillmore	D	None---------	---	---	+.5-1.0	Perched	Mar-Jul	>60	---	High-----	High-----	Low.
GeD2--------------- Geary	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Low------	Low.
Ha----------------- Haynie	B	Occasional	Very brief	Feb-Nov	>6.0	---	---	>60	---	High-----	Low------	Low.
HdF---------------- Hedville	D	None---------	---	---	>6.0	---	---	4-20	Hard	Moderate	Low------	Moderate.
IdF---------------- Ida	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Low------	Low.
Ju, JuC------------ Judson	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Low.
Ke----------------- Kennebec	B	Occasional	Brief-----	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	>60	---	High-----	Moderate	Low.
MaC, MaC2, MaD, MaD2, MaE2-------- Marshall	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
MeD2--------------- Mayberry	D	None---------	---	---	1.0-3.0	Perched	Mar-May	>60	---	High-----	High-----	Low.
MnC, MnD2, MnE2, MnF--------------- Monona	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Low------	Low.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
MoE2, MoG:												
Monona	B	None	---	---	>6.0	---	---	>60	---	High	Low	Low.
Ida	B	None	---	---	>6.0	---	---	>60	---	High	Low	Low.
MrD2 Morrill	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Nd Nodaway	B	Occasional	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Apr-Jul	>60	---	High	Moderate	Low.
Nh Nodaway	B	Frequent	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Apr-Jul	>60	---	High	Moderate	Low.
On Onawa	D	Occasional	Brief	Feb-Nov	3.0-4.0	Apparent	Nov-Jul	>60	---	High	High	Low.
PaD2 Pawnee	D	None	---	---	1.0-3.0	Perched	Mar-May	>60	---	High	High	Low.
Pg. Pits and dumps												
Ph. Pits												
Sa Sarpy	A	Frequent	Brief to long.	Nov-Jun	>6.0	---	---	>60	---	Low	Low	Low.
SbB:												
Sarpy	A	Occasional	Brief to long.	Nov-Jun	>6.0	---	---	>60	---	Low	Low	Low.
Haynie	B	Occasional	Very brief	Feb-Nov	>6.0	---	---	>60	---	High	Low	Low.
Sh, ShC, ShC2, ShD, ShD2, ShE2, Sk, SkB Sharpsburg	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Moderate.
SmB Sharpsburg Variant	B	None	---	---	>6.0	---	---	>60	---	High	High	High.
SoF:												
Sogn	D	None	---	---	>6.0	---	---	4-20	Hard	Moderate	Low	Low.
Rock outcrop.												
ThE Thurman	A	None	---	---	>6.0	---	---	>60	---	Low	Low	Low.
Ud. Udorthents												

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
Wt, WtC, WtC2, WtD2: Wymore	D	None	---	---	1.0-3.0	Perched	Mar-Apr	>60	---	High	High	Moderate.
Zo, Zp: Zook	C/D	Occasional	Brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-May	>60	---	High	High	Moderate.

* In the "High water table--Depth" column, 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.

TABLE 18.--ENGINEERING INDEX TEST DATA

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution							Liquid limit	Plasticity index	Particle density
			Percentage passing sieve--				Percentage smaller than--					
	AASHTO	Unified	No. 4	No. 10	No. 40	No. 200	.05 mm	.005 mm	.002 mm			
										Pct		G/cm³
Judson silt loam:[1] S80NE-125-57												
Ap-----------0-7	A-4(8)	ML, CL	100	100	100	98	92		20	33	9	2.63
Bw----------34-44	A-6(10)	CL	100	100	100	100	94		22	39	15	2.66
C-----------52-60	A-6(10)	CL	100	100	100	99	94		25	39	16	2.65
Marshall silty clay loam:[2] S80NE-25-46												
Ap-----------0-6	A-7-6(10)	ML	100	100	100	99	95		23	44	17	2.64
Bt1---------10-14	A-7-6(12)	ML	100	100	100	100	98		23	48	20	2.65
C1----------43-50	A-7-6(11)	CL, ML	100	100	100	100	98		25	42	16	2.69
Mayberry silty clay loam:[3] S79NE-25-221												
Ap-----------0-6	A-7-6(12)	CL	100	100	99	95	92		27	44	19	2.64
Bt3---------24-33	A-7-6(17)	CH	100	100	99	91	89		36	51	27	2.67
C-----------50-60	A-7-6(18)	CH	100	99	94	76	73		33	52	29	2.70
Monona silt loam:[4] S80NE-25-41												
Ap-----------0-6	A-6(9)	CL	100	100	100	99	94		21	37	13	2.66
Bt----------14-28	A-6(10)	CL, ML	100	100	100	99	93		20	40	15	2.68
C3----------48-60	A-4(8)	ML	100	100	100	99	92		12	35	10	2.68
Nodaway silt loam:[5] S80NE-25-19												
Ap-----------0-7	A-4(8)	ML	100	100	100	97	90		13	33	9	2.61
C------------7-60	A-4(8)	ML	100	100	100	99	13		15	33	8	2.64
Sharpsburg silty clay loam:[6] S79NE-25-217												
Ap-----------0-6	A-6(9)	ML	100	100	100	98	90		20	37	12	2.61
Bt2---------20-26	A-7-6(18)	CH	100	100	100	98	95		33	54	27	2.68
C-----------45-60	A-7-6(14)	CL	100	100	100	100	95		25	45	22	2.69

TABLE 18.--ENGINEERING INDEX TEST DATA--Continued

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution							Liquid limit	Plasticity index	Particle density
			Percentage passing sieve--				Percentage smaller than--					
	AASHTO	Unified	No. 4	No. 10	No. 40	No. 200	.05 mm	.005 mm	.002 mm			
										Pct		G/cm3
Wymore silty clay loam:[7] S80NE-25-21												
Ap------------0-6	A-7-6(10)	ML	100	100	100	98	91		23	41	15	2.60
Bt1----------14-23	A-7-6(19)	CH	100	100	99	92	89		37	55	29	2.69
C------------48-60	A-7-6(16)	CL, CH	100	100	100	99	97		31	50	26	2.69

1 Judson silt loam: 1,000 feet south and 100 feet west of the northeast corner of sec. 7, T. 11 N., R. 11 W.

2 Marshall silty clay loam: 1,750 feet west and 100 feet north of the southeast corner of sec. 2, T. 11 N., R. 13 E.

3 Mayberry silty clay loam: 900 feet south and 100 feet west of the northeast corner of sec. 36, T. 10 N., R. 9 E.

4 Monona silt loam: 2,400 feet east and 800 feet south of the northwest corner of sec. 21, T. 11 N., R. 14 E.

5 Nodaway silt loam: 600 feet west and 350 feet south of the northeast corner of sec. 4 T. 10 N., R. 11 E.

6 Sharpsburg silty clay loam: 2,100 feet south and 100 feet west of the northeast corner of sec. 13, T. 11 N., R. 10 E.

7 Wymore silty clay loam: 150 feet north and 250 feet west of the southeast corner of sec. 24, T. 10 N., R. 9 E.

TABLE 19.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Albaton	Fine, montmorillonitic (calcareous), mesic Vertic Fluvaquents
Burchard	Fine-loamy, mixed, mesic Typic Argiudolls
*Colo	Fine-silty, mixed, mesic Cumulic Haplaquolls
Fillmore	Fine, montmorillonitic, mesic Typic Argialbolls
*Geary	Fine-silty, mixed, mesic Udic Argiustolls
Haynie	Coarse-silty, mixed (calcareous), mesic Mollic Udifluvents
Hedville	Loamy, mixed, mesic Lithic Haplustolls
*Ida	Fine-silty, mixed (calcareous), mesic Typic Udorthents
Judson	Fine-silty, mixed, mesic Cumulic Hapludolls
Kennebec	Fine-silty, mixed, mesic Cumulic Hapludolls
Marshall	Fine-silty, mixed, mesic Typic Hapludolls
*Mayberry	Fine, montmorillonitic, mesic Aquic Argiudolls
Monona	Fine-silty, mixed, mesic Typic Hapludolls
Morrill	Fine-loamy, mixed, mesic Typic Argiudolls
Nodaway	Fine-silty, mixed, nonacid, mesic Mollic Udifluvents
Onawa	Clayey over loamy, montmorillonitic (calcareous), mesic Mollic Fluvaquents
Pawnee	Fine, montmorillonitic, mesic Aquic Argiudolls
Sarpy	Mixed, mesic Typic Udipsamments
Sharpsburg	Fine, montmorillonitic, mesic Typic Argiudolls
Sharpsburg Variant	Fine, montmorillonitic, mesic Typic Argiudolls
Sogn	Loamy, mixed, mesic Lithic Haplustolls
*Thurman	Sandy, mixed, mesic Udorthentic Haplustolls
Udorthents	Mixed, mesic Typic Udorthents
Wymore	Fine, montmorillonitic, mesic Aquic Argiudolls
Zook	Fine, montmorillonitic, mesic Cumulic Haplaquolls

* The soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series.

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