United States Department of Agriculture

Natural Resources Conservation Service

In cooperation with the Oregon Agricultural Experiment Station

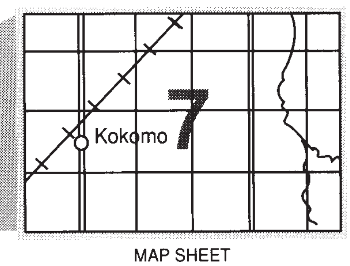
Soil Survey of Sherman County, Oregon

How to Use This Soil Survey

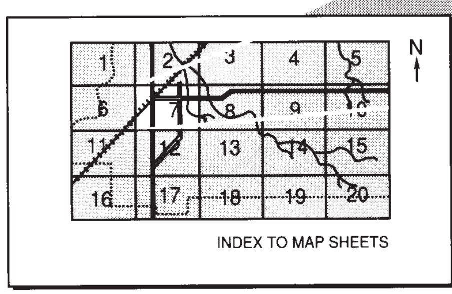
General Soil Map

The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

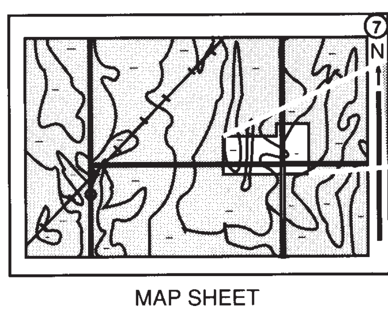


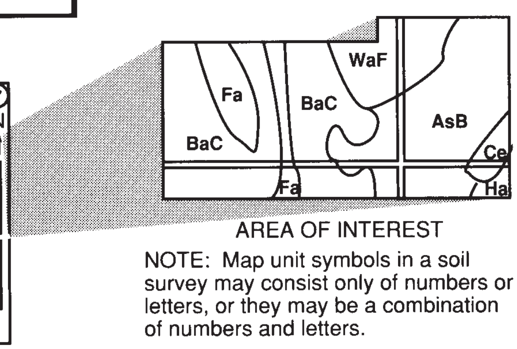
Detailed Soil Maps



The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet and turn to that sheet.





Locate your area of interest on the map sheet. Note the map units symbols that are in that area. Turn to the **Contents**, which lists the map units by symbol and name and shows the page where each map unit is described.

The **Contents** shows which table has data on a specific land use for each detailed soil map unit. Also see the **Contents** for sections of this publication that may address your specific needs.

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

Major fieldwork for this soil survey was completed in 1992. Soil names and descriptions were approved in 1992. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1992. This survey was made cooperatively by the Natural Resources Conservation Service and the Oregon Agricultural Experiment Station. The survey is part of the technical assistance furnished to the Sherman County Soil and Water Conservation District.

Since the publication of this survey, more information on soil properties may have been collected, new interpretations developed, or existing interpretive criteria modified. The most current soil information and interpretations for this survey are in the Field Office Technical Guide (FOTG) at the local office of the Natural Resources Conservation Service. The soil maps in this publication may exist in digital form in a full quadrangle format. The digitizing of the maps is in accordance with the Soil Survey Geographic (SSURGO) database standards. During the digitizing process, changes or corrections to the maps may have occurred. These changes or corrections improve the matching of this survey to adjacent surveys and correct previous errors or omissions of map unit symbols or lines. If digital SSURGO-certified maps exist for this survey, they are considered the official maps for the survey area and are part of the FOTG at the local office of the Natural Resources Conservation Service.

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

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Cover: Wheat in an area of Walla Walla silt loam, 1 to 7 percent slopes (photograph by Evan Schneider).

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

Contents

Issued 1999

Foreword

This soil survey contains information that affects land use planning in this survey area. It contains predictions of soil behavior for selected land uses. The survey also highlights soil limitations, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

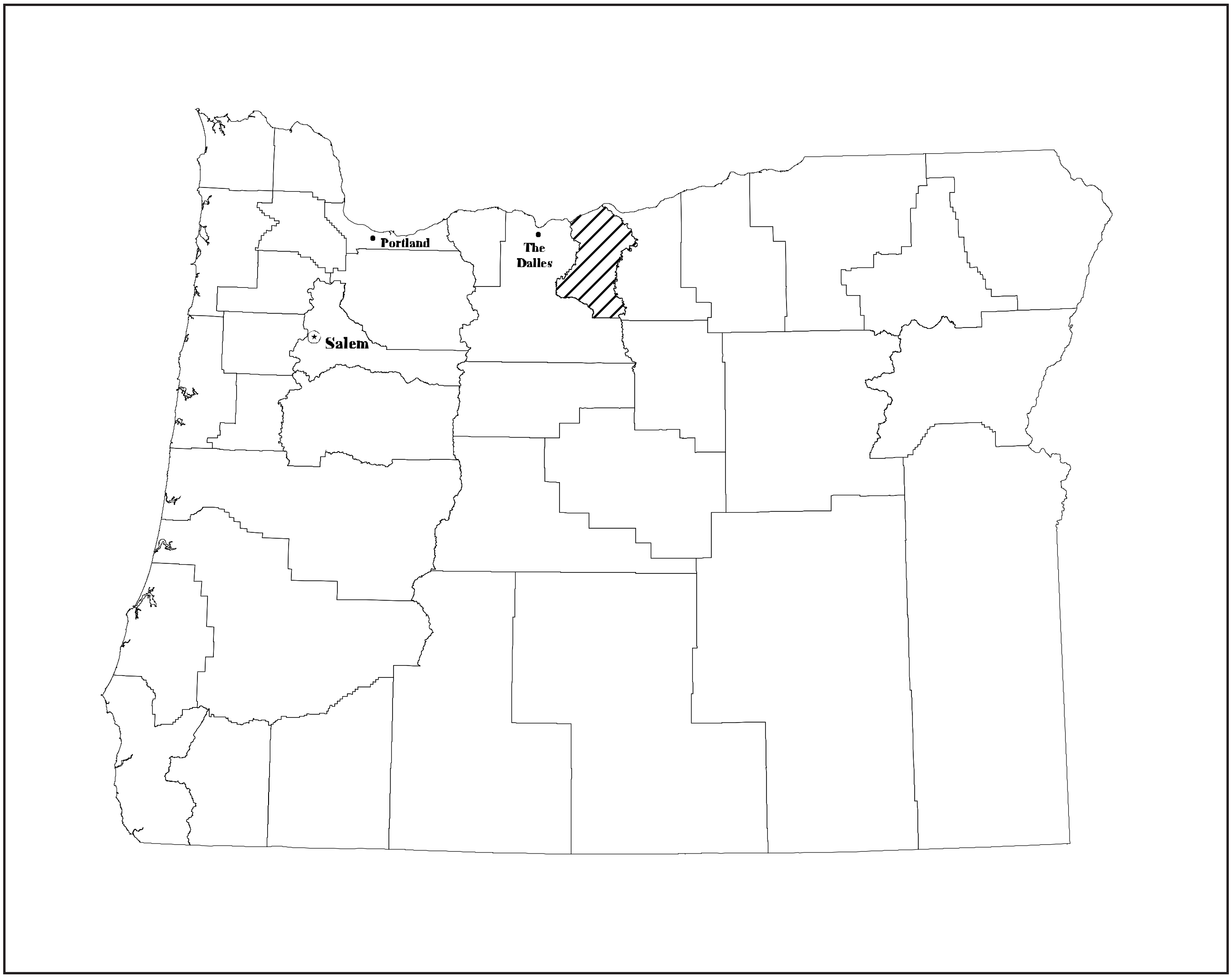
This soil survey is designed for many different users. Farmers, ranchers, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey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

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. The information in this report is intended to identify soil properties that are used in making various land use or land treatment decisions. Statements made in this report are intended to help the land users identify and reduce the effects of soil limitations that affect various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

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

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

Bob Graham
State Conservationist
Natural Resources Conservation Service



Location of Sherman County in Oregon.

Soil Survey of Sherman County, Oregon

By Gerald D. Macdonald, James M. Lamkin, and Roger H. Borine, Natural Resources Conservation Service

Fieldwork by James M. Lamkin and Roger H. Borine, Natural Resources Conservation Service

United States Department of Agriculture, Natural Resources Conservation Service, in cooperation with the Oregon Agricultural Experiment Station

SHERMAN COUNTY is in the north-central part of Oregon. It has a total area of about 827 square miles, or about 532,000 acres. The county is bounded on the north by the Columbia River, on the west by the Deschutes River, on the east by the John Day River, and on the south by Wasco County.

Sherman County has a population of about 1,800, most of whom live in Kent, Grass Valley, Moro, and Wasco. Moro, which is in the central part, is the county seat.

A branch of the Burlington Northern Railroad extends from Biggs, on the main line along the Columbia River, to Kent, near the southern border of the county. U.S. Highway 97 runs from north to south through the central part of the county.

The economy of the county is dependent mainly on agriculture. The main crop is irrigated small grain. Nearly all of the grain is shipped by rail.

This soil survey updates the survey of Sherman County, Oregon, published in 1964 *(6)*.

General Nature of the County

This section gives general information about the county. It discusses history and development; physiography, relief, and drainage; geology; and climate.

History and Development

The first person to explore what is now Sherman County was Major Enoch Steen. Major Steen left The Dalles on May 19, 1860, to explore southeastern Oregon at the request of General William Harney, who wanted to develop a road to the Northwest.

The first settlement in the county was established in 1860, when William Graham crossed to the east bank of the Deschutes River to tend the bridge and to establish a hotel. This was almost 20 years after settlers had begun traveling across the county in covered wagons on the last leg of their long trip from the East and 10 years after stagelines had crossed the county on the trip from The Dalles to Umatilla Landing, where pack outfits and freighters' wagons left for mines in Idaho.

Stockmen gradually moved into the area during the 1860's and 1870's. Most of them raised horses to sell to settlers in the Willamette Valley. Cattle had limited value until the completion of the intercontinental railroad. With the railroad in place, cattle could be transported to markets great distances away; thus, the great western cattle drives began.

A railroad built along the Columbia River around 1880 brought emigrants from Europe and the former Confederate States to the area. By 1885 most of the available land was settled and was being used for farming and livestock production.

The county government was established in 1889, when Sherman County was separated from Wasco County. The population of the county peaked at 4,242 in 1910. It has declined since to about 1,800 at present.

Physiography, Relief, and Drainage

Sherman County is entirely within the Columbia Plateau major land resource area. The soils of the Columbia Plateau area are on gently sloping mesas and ridgetops and very steep canyonsides. This area is characterized by basalt flows overlain by an accumulation of loess. Elevation ranges from 170 feet along the Columbia River to about 3,000 feet in the southern part of the county.

Gordon Ridge, 2 miles north of Moro, separates the western half of the county into two major drainage areas. The tributaries in the northwestern part of the county, between Moro and Wasco, drain to the northwest into the Columbia River. The tributaries south of Gordon Ridge and west of Moro, Grass Valley, and Kent drain to the west and southwest into the Deschutes River. The tributaries in the eastern half of the county drain to the east into the John Day River. The tributaries of all of these rivers flow through deep, *V*-shaped canyons.

Geology

The soils of Sherman County have been influenced by two major geologic formations—the Yakima Formation of the Columbia River Group of the Miocene and the Shutler Formation of the Pliocene.

The Yakima Formation is most prominent in the county, occurring dominantly south of Gordon Ridge and DeMoss Springs and extending south to the Wasco County line. It consists of basalt and andesite flows and breccia that are about 13 to 16 million years old. It is part of a widespread series of flows that extend from Astoria, in the western part of Oregon, east into Idaho and north into Washington. These lava flows typically are 25 to 100 feet thick and consist of fine-grained, dark gray basalt. The exposed upper part of these flows normally is oxidized and partially weathered so that shades of red and brown are common. The red and brown colors of the Bakeoven and Lickskillet soils are the result of this weathering of iron-bearing minerals. The lava flows have interbedding of Paleosols, boulders, volcanic ash, and cinders.

The Shutler Formation occurs dominantly north of Gordon Ridge and DeMoss Springs and extends north to the Columbia River. It consists of interbedded basalt flows and ashflow tuff that are about 4.0 to 9.7 million years old and typically are 1 foot to 3 feet thick. The base of this formation consists of water-worked gravel and cobbles, several layers of sand and silt, volcanic ash, and diatomite separated by or coated with caliche. Erosional remnants indicate that the Shutler Formation once covered a much larger area but has since been eroded. The Anderly, Anders, Walla Walla, and Wato soils typically are underlain by the Shutler Formation. These soils have concentrations of calcium carbonates in the few inches above the caliche.

Ten percent of the county reflects a unique geologic feature that occurs under glacial influence and is referred to as patterned ground, locally known as “Biscuit Scabland.” The main climatic significance of the soil patterns on this surface is that frozen ground apparently existed in front of the continental glacier during glacial invasion. It appears that a regular pattern of polygonal fractures formed as a result of contraction during periods of subfreezing temperatures in ground frozen to a uniform depth. Ice wedges probably formed in these fractures when the temperature fluctuated but generally remained below freezing *(3)*. Then as the climate became warmer and the front of the continental glacier retreated northward, the ice wedges began to melt. The runoff could have caused the erosion and modification of the polygons. Frost heaving probably mixed the genetically formed horizons. The removal of large amounts of mineral soil during the formation of the mounds is obvious from the scabland that surrounds the mounds. The soils of the scabland formed mainly in remnants of material not removed during the thawing of the ice wedges and in material more recently washed from the mounds. Condon-Bakeoven complex, 2 to 20 percent slopes, is an example.

Climate

By the Natural Resources Conservation Service, Water and Climate Center, Portland, Oregon.

The temperature and precipitation data in this section was recorded at Moro, Oregon, and the thunderstorm, relative humidity, percent sunshine, and wind data were estimated from data recorded at the first order station at Pendleton, Oregon.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Moro in the period 1961 to 1990. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on the length of the growing season.

In winter, the average temperature is 32.9 degrees F and the average daily minimum temperature is 25.9 degrees. The lowest temperature on record, which occurred at Moro on February 2, 1950, is -23 degrees. In summer, the average temperature is 65.4 degrees and the average daily maximum temperature is 79.0 degrees. The highest temperature on record, which occurred at Moro on July 27, 1939, is 111 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 (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 11.11 inches. Of this, about 2.65 inches, or 24 percent, usually falls in May through September. The growing season for most crops falls within this period. The heaviest 1-day rainfall during the period of record was 1.67 inches at Moro on January 9, 1953. Thunderstorms occur on about 10 days each year, and most occur in June.

The average seasonal snowfall is 18.9 inches. The greatest snow depth at any one time during the period of record was 20 inches recorded on February 4, 1950. On an average, 27 days per year have at least 1 inch of snow on the ground. The heaviest 1-day snowfall on record was 12 inches recorded on February 5, 1948.

The average relative humidity in midafternoon is about 48 percent. Humidity is higher at night, and the average at dawn is about 70 percent. The sun shines 80 percent of the time in summer and 30 percent in winter. The prevailing wind is from the west. Average windspeed is highest, 9.9 miles per hour, in April.

How This Survey Was Made

Roger Borine, soil scientist, Natural Resources Conservation Service, helped to prepare this section.

This survey was made to provide information about the soils and miscellaneous areas in the survey area. The information includes a description of the soils and miscellaneous areas and their location and a discussion of their suitability and limitations. Prior to publishing the Sherman County, Oregon, soil survey in 1964 *(6)*, soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

A review of the 1964 Sherman County soil survey was conducted in 1986. The soil map and soil descriptions and interpretations were reviewed for technical accuracy. Transects were made in representative areas throughout the county to determine accuracy of existing soil map units with respect to soil series, phases, and composition. The existing soil map units were evaluated according to the current standards of the National Cooperative Soil Survey.

It was determined that the soil series were consistent with current criteria and standards. The series were then assigned to taxonomic classes. Soil phase criteria, such as slope, were adjusted only minimally to better fit the features of the landscape. Soil map unit composition and delineations were determined to be accurate by conducting field evaluation.

The soil map unit delineations were transferred from the photomosaic of the 1964 survey to orthophoto quadrangles by using photointerpretation and stereoscopic techniques, considering topographic features, and taking advantage of professional experience. Placement of the lines on the orthophoto quadrangles was verified by conducting field evaluation. Soil map unit descriptions were revised to reflect changes in the names and phases.

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

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-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 color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After completing the review of the survey area, 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. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

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

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

General Soil Map Units

The general soil map shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, it consists of one or more major soils or miscellaneous areas and some minor soils or miscellaneous areas. It is named for the major soils or miscellaneous areas. The components of one map unit can occur in another but in a different pattern.

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

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

Soil Descriptions

Soils on Mesas

1. Wato-Anders

Very deep and moderately deep, well drained very fine sandy loam that formed in loess over basalt in a 12- to 13-inch precipitation zone; on mesas

This map unit is in the northwestern part of the survey area. The native vegetation in areas not cultivated is mainly bluebunch wheatgrass, Idaho fescue, needleandthread, and Sandberg bluegrass. Elevation ranges from 200 to 2,000 feet. Slopes range from 3 to 35 percent. The mean annual precipitation is 12 to 13 inches, the mean annual air temperature is 49 to 51 degrees F, and the frost-free period is 110 to 150 days.

This map unit makes up about 3 percent of the survey area. It is about 82 percent Wato soils and 10 percent Anders soils. The rest is soils of minor extent.

Wato soils are very deep and well drained. The surface layer is very dark brown very fine sandy loam. The subsoil is dark brown very fine sandy loam.

Anders soils are moderately deep and well drained. The surface layer is very dark grayish brown very fine sandy loam. The subsoil is dark brown very fine sandy loam, silt loam, or gravelly silt loam.

Of minor extent in this unit are very deep Quincy soils on dunes and terraces adjacent to the Columbia River and its tributaries.

The soils in this unit are used mainly for wheat and barley grown in a grain-summer fallow system and for alfalfa hay. Areas too steep for cultivation are used for livestock grazing and as wildlife habitat.

Small populations of mule deer use areas of this unit that have an abundance of grasses, forbs, and shrubs and cultivated areas that produce food such as green winter wheat, grain stubble, and alfalfa hay. Adjacent brushy draws and canyons generally provide water and cover. Distribution of the deer is largely dependent on the sources of water.

The gently sloping to strongly sloping areas of this unit provide food and cover for upland game birds such as ring-necked pheasant and valley quail. These birds use the grain stubble for food and the brushy fence rows and draws for cover. The steeper areas and the areas along streams provide suitable habitat for chukar and Hungarian partridge. Because this unit is near the Columbia River, habitat for abundant varieties of waterfowl is provided by perennial streams, stock ponds, and reservoirs. Canadian geese occasionally feed in the upland wheatfields.

2. Walla Walla-Anderly

Very deep to moderately deep, well drained silt loam that formed in loess over basalt in a 12- to 13-inch precipitation zone; on mesas

This map unit is on mesas in the north-central part of the survey area (see fig. 1, next page). The native vegetation in areas not cultivated is mainly bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass. Elevation ranges from 500 to 2,000 feet. Slopes range from 1 to 35 percent. The mean annual precipitation is 12 to 13 inches, the mean annual air temperature is 49 to 51 degrees F, and the frost-free period is 110 to 150 days.

Figure 1.—Typical area of general soil map unit 2.

This map unit makes up about 33 percent of the survey area. It is about 73 percent Walla Walla soils and 22 percent Anderly soils. The rest is soils of minor extent.

Walla Walla soils are very deep or deep and are well drained. The surface layer is very dark brown silt loam. The subsoil is dark brown silt loam.

Anderly soils are moderately deep and well drained. The surface layer is very dark grayish brown silt loam. The subsoil is dark brown silt loam.

Of minor extent in this unit are very deep Endersby soils on terraces, very deep Hermiston soils on flood plains, and shallow Kuhl soils on north-facing canyonsides.

The soils in this unit are used mainly for wheat and barley grown in a grain-summer fallow system, for alfalfa hay, and as pasture. Areas too steep for cultivation are used for livestock grazing and as wildlife habitat.

This unit provides food and cover for mule deer and small populations of elk and antelope. These large game animals extensively use areas of this unit that have an abundance of grasses, forbs, and shrubs and cultivated areas that produce food such as green winter wheat, grain stubble, irrigated alfalfa, and pasture grasses. Adjacent brushy draws and canyons generally provide water and cover. Distribution of the animals is largely dependent on the sources of water.

The gently sloping to strongly sloping areas of this unit provide food and cover for upland game birds such as ring-necked pheasant and valley quail. These birds use the grain stubble for food and the brushy fence rows and draws for cover. The steeper areas and the areas along streams provide suitable habitat for chukar and Hungarian partridge. A few waterfowl use the perennial streams, stock ponds, and reservoirs in fall and winter. Canadian geese occasionally feed in the upland wheatfields.

3. Mikkalo-Ritzville

Moderately deep and deep, well drained silt loam that formed in loess over basalt in a 9- to 11-inch precipitation zone; on mesas

This map unit is in the northeastern corner of the survey area, above the John Day River. The native vegetation in areas not cultivated is mainly bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, and basin big sagebrush. Elevation ranges from 1,000 to 2,000 feet. Slopes range from 2 to 35 percent. The mean annual precipitation is 9 to 11 inches, the mean annual air temperature is 49 to 51 degrees F, and the frost-free period is 110 to 150 days.

This map unit makes up about 3 percent of the survey area. It is about 56 percent Mikkalo soils and 38 percent Ritzville soils. The rest is soils of minor extent.

Mikkalo soils are moderately deep and well drained. The surface layer is very dark grayish brown silt loam. The subsoil is dark brown, calcareous silt loam.

Ritzville soils are deep and well drained. The surface layer is dark brown silt loam. The subsoil is dark yellowish brown, calcareous silt loam.

Of minor extent in this unit are shallow Lickskillet soils on south-facing slopes of canyons and deep Nansene soils on north-facing slopes of canyons.

The soils in this unit are used mainly for wheat and barley grown in a grain-summer fallow system. Areas too steep for cultivation are used for livestock grazing and as wildlife habitat.

This unit provides food and cover for antelope, elk, and mule deer. These large game animals extensively use areas of this unit that have an abundance of grasses, forbs, and shrubs and cultivated areas that produce food such as green winter wheat and grain stubble. Adjacent brushy draws and canyons generally provide water and cover. Distribution of the animals is largely dependent on the sources of water.

The gently sloping to strongly sloping areas of this unit provide food and cover for upland game birds such as ring-necked pheasant and valley quail. These birds use the grain stubble for food and the brushy fence rows and draws for cover. The steeper areas and the areas along streams provide suitable habitat for chukar and Hungarian partridge. A few waterfowl use the perennial streams, stock ponds, and reservoirs in fall and winter. Canadian geese occasionally feed in the upland wheatfields.

4. Condon-Cantala

Moderately deep and very deep, well drained silt loam that formed in loess over basalt in an 11- to 12-inch precipitation zone; on mesas

This map unit is in the south-central part of the survey area. The native vegetation in areas not cultivated is mainly bluebunch wheatgrass, Idaho fescue, needleandthread, Sandberg bluegrass, stiff sagebrush, and basin wildrye. Elevation ranges from 200 to 2,600 feet. Slopes range from 1 to 35 percent. The mean annual precipitation is 11 to 12 inches, the mean annual air temperature is 48 to 50 degrees F, and the frost-free period is 100 to 150 days.

This map unit makes up about 34 percent of the survey area. It is about 70 percent Condon soils and 8 percent Cantala soils. The rest is soils of minor extent.

Condon soils are moderately deep and well drained. The surface layer is very dark grayish brown silt loam. The subsoil is dark brown silt loam.

Cantala soils are very deep and well drained. The surface layer is very dark grayish brown silt loam. The subsoil is dark brown silt loam.

Of minor extent in this unit are very deep Hermiston and Pedigo soils on flood plains, very deep Endersby soils on terraces, and very shallow Bakeoven soils on mesas.

The soils in this unit are used mainly for wheat and barley grown in a grain-summer fallow system. Areas too steep for cultivation are used for livestock grazing and as wildlife habitat.

This unit provides food and cover for antelope, elk, and mule deer. These large game animals extensively use areas of this unit that have an abundance of grasses, forbs, and shrubs and cultivated areas that produce food such as green winter wheat and grain stubble. Adjacent brushy draws and canyons generally provide water and cover. Distribution of the animals is largely dependent on the sources of water.

The gently sloping to strongly sloping areas of this unit provide food and cover for upland game birds such as ring-necked pheasant and valley quail. These birds use the grain stubble for food and the brushy fence rows and draws for cover. The steeper areas and the areas along streams provide suitable habitat for chukar and Hungarian partridge. A few waterfowl use the perennial streams, stock ponds, and reservoirs in fall and winter. Canadian geese occasionally feed in the upland wheatfields.

Soils in Canyons

5. Lickskillet-Nansene

Shallow and deep, well drained very stony loam and silt loam that formed in residuum derived from basalt and in loess over basalt in a 12- to 13-inch precipitation zone; in canyons

This map unit is adjacent to the Deschutes and John Day Rivers, in the northern part of the survey area (fig. 2). The native vegetation is mainly bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, basin big sagebrush, and stiff sagebrush. Elevation ranges from 200 to 2,600 feet. Slopes range from 2 to 80 percent. The mean annual precipitation is 12 to 13 inches, the mean air annual temperature is 49 to 51 degrees F, and the frost-free period is 110 to 150 days.

Figure 2.—Typical area of general soil map unit 5 on canyonsides along the Deschutes River.

This map unit makes up about 12 percent of the survey area. It is about 45 percent Lickskillet soils and 12 percent Nansene soils. The rest is soils of minor extent.

Lickskillet soils are shallow and well drained. The surface layer is very dark grayish brown very stony loam. The upper part of the subsoil is dark brown very gravelly loam, and the lower part is dark brown very gravelly clay loam, very gravelly loam, or very cobbly loam. These soils are on south-facing canyonsides.

Nansene soils are deep and well drained. The surface layer and subsoil are very dark brown silt loam. The substratum is dark brown silt loam. These soils are on north-facing canyonsides.

Of minor extent in this unit are very shallow Bakeoven soils on ridgetops and benches of canyons, very deep Sagemoor soils on dissected terraces, and moderately deep Wrentham soils on north-facing canyonsides.

The soils in this unit are used mainly for livestock grazing and as wildlife habitat.

The steep and very steep areas of this unit and the adjacent drainageways provide food and cover for chukar, Hungarian partridge, mule deer, and elk.

This unit provides cover for ring-necked pheasant and valley quail that feed in the adjacent upland wheatfields. A few waterfowl use the Deschutes and John Day Rivers in fall and winter.

6. Wrentham-Lickskillet-Rock Outcrop

Moderately deep and shallow, well drained silt loam and very stony loam that formed in loess over basalt and in residuum derived from basalt in an 11- to 12-inch precipitation zone; in canyons

This map unit is adjacent to the Deschutes and John Day Rivers, in the southern part of the survey area. The native vegetation is mainly bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, basin big sagebrush, and stiff sagebrush. Elevation ranges from 500 to 2,800 feet. Slopes range from 7 to 80 percent. The mean annual precipitation is 11 to 12 inches, the mean annual air temperature is 48 to 50 degrees F, and the frost-free period is 100 to 150 days.

This map unit makes up about 15 percent of the survey area. It is about 30 percent Wrentham soils, 30 percent Lickskillet soils, and 26 percent Rock outcrop. The rest is soils of minor extent.

Wrentham soils are moderately deep and well drained. The surface layer is very dark brown silt loam. The subsoil is dark brown extremely cobbly silt loam. These soils are on north-facing canyonsides.

Lickskillet soils are shallow and well drained. The surface layer is very dark grayish brown very stony loam. The upper part of the subsoil is dark brown very gravelly loam, and the lower part is dark brown very gravelly clay loam, very gravelly loam, or very cobbly loam. These soils are on south-facing canyonsides.

Rock outcrop consists of areas of exposed bedrock on the shoulders and convex side slopes of very steep canyons.

Of minor extent in this unit are very deep Sagemoor soils on dissected terraces.

The soils in this unit are used mainly for livestock grazing and as wildlife habitat.

The steep and very steep areas of this unit and the adjacent drainageways provide food and cover for chukar, Hungarian partridge, mule deer, and elk.

This unit provides cover for ring-necked pheasant and valley quail that feed in the adjacent upland wheatfields. A few waterfowl use the Deschutes and John Day Rivers in fall and winter.

Detailed Soil Map Units

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

A map unit delineation on a map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils or miscellaneous areas. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils and miscellaneous areas are natural phenomena, and they have the characteristic variability of all natural phenomena. 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 other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some “included” areas that belong to other taxonomic classes.

Most included soils have properties 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, or similar, inclusions. They may or may not be mentioned in the map unit description. Other included soils and miscellaneous areas, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, inclusions. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. The included areas of contrasting soils or miscellaneous areas are mentioned in the map unit descriptions. A few included areas may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

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

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit 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, 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, slope, stoniness, salinity, 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, Walla Walla silt loam, 1 to 7 percent slopes, is a phase of the Walla Walla series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Lickskillet-Bakeoven complex, 2 to 20 percent slopes, is an example.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Contents") 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 or miscellaneous areas.

In the map unit descriptions that follow, a semitabular format is used. In this format a boldface heading (for example, ***Composition***) is used to identify the kind of information grouped directly below it. Introducing each item of information under the heading is an italicized term or phrase (for example, *Landscape position:*) that identifies or describes the information. Many of the boldface headings and introductory terms or phrases are self-explanatory; however, some of them need further explanation. These explanations are provided in the following paragraphs, generally in the order in which they are used in the map unit descriptions.

Composition is given for the components identified in the name of the map unit as well as for the contrasting inclusions.

Inclusions are areas of components (soils or miscellaneous areas) that differ from the components for which the unit is named. Inclusions can be either similar or contrasting. *Similar inclusions* are components that differ from the components for which the unit is named but that for purposes of use and management can be considered to be the same as the named components. Note that in the "Composition" paragraph a single percentage is provided for a named soil and the similar inclusions because their use and management are similar.

Contrasting inclusions are components that differ sufficiently from the components for which the unit is named that they would have different use and management if they were extensive enough to be managed separately. For most uses, contrasting inclusions have limited effect on use and management. Inclusions generally are in small areas, and they could not be mapped separately because of the scale used. Some small areas of strongly contrasting inclusions are identified by a special symbol on the detailed soil maps. A few inclusions may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the inclusions on the landscape.

Landscape position refers to the dominant position or positions on the landform or landforms on which the component is located. In naming landscape positions, an effort has been made to give the specific position of the component rather than a general position that could encompass other components. For some landforms, such as nearly level stream terraces, distinctive landscape positions cannot be described and thus are not given.

Landform refers to the dominant three-dimensional part or parts of the land surface on which the component is located. In naming landforms, an effort has been made to name the specific landform on which the component occurs. In some instances, however, the component may occur on more than one landform.

Typical profile is a vertical, two-dimensional section of the soil extending from the surface to a restrictive layer or to a depth of 60 inches or more.

Permeability is 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.

Available water capacity is the capacity of the soil to hold water available for use by most plants. It commonly is expressed as inches of water per inch of soil (see "Glossary").

Major uses are the dominant uses at the time the major part of the fieldwork for this survey was completed.

Soil Descriptions

1B—Anderly silt loam, 1 to 7 percent slopes

Composition

Anderly soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Benches, ridgetops
Landform: Mesas
Parent material: Loess over basalt
Elevation: 1,000 to 2,000 feet
Native plants: Idaho fescue, bluebunch wheatgrass
Climatic factors:
- Mean annual precipitation—12 to 13 inches
- Mean annual air temperature—49 to 51 degrees F
- Frost-free period—110 to 150 days

Typical Profile

0 to 10 inches: Very dark grayish brown silt loam
10 to 30 inches: Dark brown silt loam
30 inches: Basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 5 to 8 inches

Contrasting Inclusions

• Walla Walla soils

Major Uses

Dryland farming, livestock grazing

1C—Anderly silt loam, 7 to 15 percent slopes

Composition

Anderly soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Benches, ridgetops
Landform: Mesas
Parent material: Loess over basalt
Elevation: 1,000 to 2,000 feet
Native plants: Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—12 to 13 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 10 inches: Very dark grayish brown silt loam
10 to 30 inches: Dark brown silt loam
30 inches: Basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 5 to 8 inches

Contrasting Inclusions

• Walla Walla soils

Major Uses

Dryland farming, livestock grazing

2D—Anderly silt loam, 15 to 35 percent north slopes

Composition

Anderly soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: North-facing side slopes
Landform: Canyons
Parent material: Loess over basalt
Elevation: 1,000 to 2,000 feet
Native plants: Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—12 to 13 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 10 inches: Very dark grayish brown silt loam
10 to 30 inches: Dark brown silt loam
30 inches: Basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 5 to 8 inches

Contrasting Inclusions

• Kuhl, Nansene, and Walla Walla soils

Major Use

Livestock grazing

3D—Anderly silt loam, 15 to 35 percent south slopes

Composition

Anderly soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: South-facing side slopes
Landform: Canyons
Parent material: Loess over basalt
Elevation: 1,000 to 2,000 feet
Native plants: Bluebunch wheatgrass, Sandberg bluegrass

Climatic factors:
Mean annual precipitation—12 to 13 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 10 inches: Very dark grayish brown silt loam
10 to 30 inches: Dark brown silt loam
30 inches: Basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 5 to 8 inches

Contrasting Inclusions

• Bakeoven, Lickskillet, and Walla Walla soils

Major Use

Livestock grazing

4B—Anders very fine sandy loam, 3 to 7 percent slopes

Composition

Anders soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Benches, ridgetops
Landform: Mesas
Parent material: Loess over basalt
Elevation: 1,000 to 2,000 feet
Native plants: Needleandthread, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—12 to 13 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 13 inches: Very dark grayish brown very fine sandy loam
13 to 33 inches: Dark brown very fine sandy loam
33 inches: Basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 4 to 7 inches

Contrasting Inclusions

• Wato soils

Major Uses

Dryland farming, livestock grazing

4C—Anders very fine sandy loam, 7 to 15 percent slopes

Composition

Anders soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Benches, ridgetops
Landform: Mesas
Parent material: Loess over basalt
Elevation: 1,000 to 2,000 feet
Native plants: Needleandthread, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—12 to 13 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 13 inches: Very dark grayish brown very fine sandy loam
13 to 33 inches: Dark brown very fine sandy loam
33 inches: Basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 4 to 7 inches

Contrasting Inclusions

• Wato soils

Major Uses

Dryland farming, livestock grazing

5D—Anders very fine sandy loam, 15 to 35 percent south slopes

Composition

Anders soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: South-facing side slopes
Landform: Canyons
Parent material: Loess over basalt
Elevation: 1,000 to 2,000 feet
Native plants: Bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—12 to 13 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 13 inches: Very dark grayish brown very fine sandy loam
13 to 33 inches: Dark brown very fine sandy loam
33 inches: Basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 4 to 7 inches

Contrasting Inclusions

- Bakeoven, Lickskillet, and Wato soils

Major Use

Livestock grazing

6C—Bakeoven very stony loam, 2 to 20 percent slopes

Composition

Bakeoven soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Benches, ridgetops
Landform: Mesas
Parent material: Kind—residuum; source—basalt
Elevation: 2,000 to 2,600 feet
Native plants: Stiff sagebrush, Sandberg bluegrass, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—11 to 12 inches
Mean annual air temperature—48 to 50 degrees F
Frost-free period—100 to 150 days

Typical Profile

0 to 2 inches: Dark brown very stony loam
2 to 7 inches: Dark yellowish brown very cobbly loam
7 inches: Basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of less than 10 inches
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 1 to 2 inches

Contrasting Inclusions

- Anderly, Condon, and Lickskillet soils
- Rock outcrop

Major Use

Livestock grazing

7B—Cantala silt loam, 1 to 7 percent slopes

Composition

Cantala soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Benches, ridgetops
Landform: Mesas
Parent material: Loess
Elevation: 2,000 to 2,600 feet
Native plants: Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—11 to 12 inches
Mean annual air temperature—48 to 50 degrees F
Frost-free period—100 to 150 days

Typical Profile

0 to 15 inches: Very dark grayish brown silt loam
15 to 60 inches: Dark brown silt loam

Soil Properties and Qualities

Depth: Bedrock at a depth of more than 60 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 11 to 13 inches

Contrasting Inclusions

- Bakeoven and Condon soils

Major Uses

Dryland farming, livestock grazing

7C—Cantala silt loam, 7 to 15 percent slopes

Composition

Cantala soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Benches, ridgetops
Landform: Mesas
Parent material: Loess
Elevation: 2,000 to 2,600 feet
Native plants: Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—11 to 12 inches
Mean annual air temperature—48 to 50 degrees F
Frost-free period—100 to 150 days

Typical Profile

0 to 15 inches: Very dark grayish brown silt loam
15 to 60 inches: Dark brown silt loam

Soil Properties and Qualities

Depth: Bedrock at a depth of more than 60 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 11 to 13 inches

Contrasting Inclusions

- Bakeoven and Condon soils

Major Uses

Dryland farming, livestock grazing

8B—Condon silt loam, 1 to 7 percent slopes

Composition

Condon soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Benches, ridgetops
Landform: Mesas
Parent material: Loess over basalt
Elevation: 2,000 to 2,600 feet
Native plants: Idaho fescue, bluegrass wheatgrass
Climatic factors:
Mean annual precipitation—11 to 12 inches
Mean annual air temperature—48 to 50 degrees F
Frost-free period—100 to 150 days

Typical Profile

0 to 12 inches: Very dark grayish brown silt loam
12 to 30 inches: Dark brown silt loam
30 inches: Basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 4 to 7 inches

Contrasting Inclusions

- Bakeoven and Cantala soils

Major Uses

Dryland farming, livestock grazing

8C—Condon silt loam, 7 to 15 percent slopes

Composition

Condon soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Benches, ridgetops

Landform: Mesas
Parent material: Loess over basalt
Elevation: 2,000 to 2,600 feet
Native plants: Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—11 to 12 inches
Mean annual air temperature—48 to 50 degrees F
Frost-free period—100 to 150 days

Typical Profile

0 to 12 inches: Very dark grayish brown silt loam
12 to 30 inches: Dark brown silt loam
30 inches: Basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 4 to 7 inches

Contrasting Inclusions

- Bakeoven and Cantala soils

Major Uses

Dryland farming, livestock grazing

9D—Condon silt loam, 15 to 35 percent north slopes

Composition

Condon soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: North-facing side slopes
Landform: Canyons
Parent material: Loess over basalt
Elevation: 2,000 to 2,600 feet
Native plants: Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—11 to 12 inches
Mean annual air temperature—48 to 50 degrees F
Frost-free period—100 to 150 days

Typical Profile

0 to 12 inches: Very dark grayish brown silt loam
12 to 30 inches: Dark brown silt loam
30 inches: Basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 4 to 7 inches

Contrasting Inclusions

- Cantala, Nansene, and Wrentham soils

Major Use

Livestock grazing

10C—Condon-Bakeoven complex, 2 to 20 percent slopes

Composition

Condon soil and similar inclusions—50 percent
Bakeoven soil and similar inclusions—40 percent
Contrasting inclusions—10 percent

Setting

Landscape position: Condon soil—mounds on benches and ridgetops; Bakeoven soil—intermounds on benches and ridgetops
Landform: Mesas
Parent material: Condon soil—loess over basalt; Bakeoven soil—residuum derived from basalt
Elevation: 2,000 to 2,600 feet
Native plants: Idaho fescue, bluebunch wheatgrass, Sandberg bluegrass, stiff sagebrush
Climatic factors:
Mean annual precipitation—11 to 12 inches
Mean annual air temperature—48 to 50 degrees F
Frost-free period—100 to 150 days

Characteristics of the Condon Soil

Typical Profile

0 to 12 inches: Very dark grayish brown silt loam
12 to 30 inches: Dark brown silt loam
30 inches: Basalt

Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 4 to 7 inches

Characteristics of the Bakeoven Soil

Typical Profile

0 to 2 inches: Dark brown very stony loam
2 to 7 inches: Dark yellowish brown very cobbly loam
7 inches: Basalt

Properties and Qualities

Depth: Bedrock at a depth of 4 to 10 inches
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 1 to 2 inches

Contrasting Inclusions

- Cantala and Lickskillet soils
- Rock outcrop

Major Use

Livestock grazing

11A—Endersby fine sandy loam, 0 to 3 percent slopes

Composition

Endersby soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landform: Terraces
Parent material: Alluvium
Elevation: 200 to 2,000 feet
Native plants: Basin wildrye, needleandthread, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—11 to 12 inches
Mean annual air temperature—48 to 50 degrees F
Frost-free period—100 to 150 days

Typical Profile

0 to 16 inches: Very dark grayish brown fine sandy loam
16 to 31 inches: Very dark grayish brown fine sandy loam
31 to 40 inches: Very dark grayish brown very gravelly sand
40 to 60 inches: Stratified silt loam, sandy loam, and loamy sand

Soil Properties and Qualities

Depth: Bedrock at a depth of more than 60 inches
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 5 to 8 inches
Flooding: Rare

Contrasting Inclusions

- Condon, Hermiston, and Walla Walla soils
- Riverwash

Major Uses

Dryland farming, irrigated hay and pasture, livestock grazing

12A—Endersby-Hermiston complex, 0 to 3 percent slopes

Composition

Endersby soil and similar inclusions—55 percent
Hermiston soil and similar inclusions—35 percent
Contrasting inclusions—10 percent

Setting

Landform: Endersby soil—terraces; Hermiston soil—flood plains
Parent material: Alluvium
Elevation: 200 to 2,000 feet
Native plants: Basin wildrye, needleandthread, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—11 to 12 inches
Mean annual air temperature—48 to 50 degrees F
Frost-free period—100 to 150 days

Characteristics of the Endersby Soil

Typical Profile

0 to 16 inches: Very dark grayish brown fine sandy loam
16 to 31 inches: Very dark grayish brown fine sandy loam
31 to 40 inches: Very dark grayish brown very gravelly sand
40 to 60 inches: Very dark grayish brown and black extremely gravelly sand

Properties and Qualities

Depth: Bedrock at a depth of more than 60 inches

Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 5 to 8 inches
Flooding: Rare

Characteristics of the Hermiston Soil

Typical Profile

0 to 21 inches: Dark brown silt loam
21 to 37 inches: Dark grayish brown and dark brown, calcareous very fine sandy loam
37 to 60 inches: Dark brown silt loam

Properties and Qualities

Depth: Bedrock at a depth of more than 60 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 9 to 12 inches
Flooding: Rare

Contrasting Inclusions

- Condon and Walla Walla soils
- Riverwash

Major Uses

Dryland farming, irrigated hay and pasture, livestock grazing

13A—Hermiston silt loam, 0 to 3 percent slopes

Composition

Hermiston soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landform: Flood plains
Parent material: Alluvium
Elevation: 200 to 2,000 feet
Native plants: Basin wildrye
Climatic factors:
Mean annual precipitation—11 to 12 inches
Mean annual air temperature—48 to 50 degrees F
Frost-free period—100 to 150 days

Typical Profile

0 to 21 inches: Dark brown silt loam
21 to 37 inches: Dark grayish brown and dark brown, calcareous very fine sandy loam
37 to 60 inches: Dark brown silt loam

Soil Properties and Qualities

Depth: Bedrock at a depth of more than 60 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 9 to 12 inches
Flooding: Rare

Contrasting Inclusions

- Condon, Endersby, and Walla Walla soils
- Riverwash

Major Uses

Dryland farming, irrigated hay and pasture, livestock grazing

14C—Kuhl very stony very fine sandy loam, 3 to 20 percent slopes

Composition

Kuhl soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Side slopes
Landform: Canyons
Parent material: Loess over basalt
Elevation: 500 to 1,500 feet
Native plants: Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—12 to 13 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 5 inches: Very dark grayish brown very stony very fine sandy loam
5 to 17 inches: Dark brown stony silt loam
17 inches: Basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 1 to 3 inches

Contrasting Inclusions

- Anderly, Anders, Bakeoven, and Nansene soils
- Rock outcrop

Major Use

Livestock grazing

15D—Kuhl-Rock outcrop complex, 20 to 40 percent north slopes

Composition

Kuhl soil and similar inclusions—50 percent
Rock outcrop—35 percent
Contrasting inclusions—15 percent

Setting

Landscape position: North-facing side slopes
Landform: Canyons
Parent material: Loess over basalt
Elevation: 500 to 1,500 feet
Native plants: Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—12 to 13 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Characteristics of the Kuhl Soil

Typical Profile

0 to 5 inches: Very dark grayish brown very stony very fine sandy loam
5 to 17 inches: Dark brown stony silt loam
17 inches: Basalt

Properties and Qualities

Depth: Bedrock at a depth of 10 to 20 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 1 to 3 inches

Characteristics of the Rock Outcrop

Kind of material: Exposed bedrock, typically basalt

Contrasting Inclusions

- Anderly, Anders, and Nansene soils
- Lickskillet and Bakeoven soils on south-facing slopes

Major Use

Livestock grazing

16D—Lickskillet very stony loam, 7 to 40 percent south slopes

Composition

Lickskillet soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: South-facing side slopes
Landform: Canyons
Parent material: Kind—residuum; source—basalt
Elevation: 200 to 2,800 feet
Native plants: Bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—11 to 13 inches
Mean annual air temperature—48 to 51 degrees F
Frost-free period—100 to 150 days

Typical Profile

0 to 9 inches: Very dark grayish brown very stony loam
9 to 13 inches: Dark brown very gravelly loam
13 to 19 inches: Dark brown very gravelly clay loam
19 inches: Basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 12 to 20 inches
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 1 to 3 inches

Contrasting Inclusions

- Bakeoven and Kuhl soils
- Wrentham and Nansene soils on north-facing slopes
- Rock outcrop

Major Use

Livestock grazing

17C—Lickskillet-Bakeoven complex, 2 to 20 percent slopes

Composition

Lickskillet soil and similar inclusions—50 percent
Bakeoven soil and similar inclusions—40 percent
Contrasting inclusions—10 percent

Setting

Landscape position: Ridgetops
Landform: Canyons
Parent material: Kind—residuum; source—basalt
Elevation: 2,000 to 2,600 feet
Native plants: Bluebunch wheatgrass, Sandberg bluegrass, stiff sagebrush
Climatic factors:
Mean annual precipitation—11 to 13 inches
Mean annual air temperature—48 to 51 degrees F
Frost-free period—100 to 150 days

Characteristics of the Lickskillet Soil

Typical Profile

0 to 9 inches: Very dark grayish brown very stony loam
9 to 13 inches: Dark brown very gravelly loam
13 to 19 inches: Dark brown very gravelly clay loam
19 inches: Basalt

Properties and Qualities

Depth: Bedrock at a depth of 12 to 20 inches
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 1 to 3 inches

Characteristics of the Bakeoven Soil

Typical Profile

0 to 2 inches: Dark brown very stony loam
2 to 7 inches: Dark yellowish brown very cobbly loam
7 inches: Basalt

Properties and Qualities

Depth: Bedrock at a depth of 4 to 10 inches
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 1 to 2 inches

Contrasting Inclusions

- Anderly, Condon, and Kuhl soils
- Rock outcrop

Major Use

Livestock grazing

18E—Lickskillet-Rock outcrop complex, 40 to 70 percent south slopes

Composition

Lickskillet soil and similar inclusions—50 percent
Rock outcrop—40 percent
Contrasting inclusions—10 percent

Setting

Landscape position: South-facing side slopes
Landform: Canyons
Parent material: Kind—residuum; source—basalt
Elevation: 200 to 2,800 feet
Native plants: Bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—11 to 13 inches
Mean annual air temperature—48 to 51 degrees F
Frost-free period—100 to 150 days

Characteristics of the Lickskillet Soil

Typical Profile

0 to 9 inches: Very dark grayish brown very stony loam
9 to 13 inches: Dark brown very gravelly loam
13 to 19 inches: Dark brown very gravelly clay loam
19 inches: Basalt

Properties and Qualities

Depth: Bedrock at a depth of 12 to 20 inches
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 1 to 3 inches

Characteristics of the Rock Outcrop

Kind of material: Exposed bedrock, typically basalt

Contrasting Inclusions

- Bakeoven and Kuhl soils
- Wrentham and Nansene soils on north-facing slopes

Major Use

Livestock grazing

19B—Mikkalo silt loam, 2 to 7 percent slopes

Composition

Mikkalo soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Benches, ridgetops
Landform: Mesas
Parent material: Loess over basalt
Elevation: 1,000 to 2,000 feet
Native plants: Basin big sagebrush, bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—9 to 11 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 12 inches: Very dark grayish brown and dark brown silt loam
12 to 27 inches: Dark brown, calcareous silt loam
27 inches: Basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 4 to 7 inches

Contrasting Inclusions

- Anderly, Kuhl, and Ritzville soils

Major Uses

Dryland farming, livestock grazing

19C—Mikkalo silt loam, 7 to 15 percent slopes

Composition

Mikkalo soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Benches, ridgetops
Landform: Mesas
Parent material: Loess over basalt
Elevation: 1,000 to 2,000 feet
Native plants: Basin big sagebrush, bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—9 to 11 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 12 inches: Very dark grayish brown and dark brown silt loam
12 to 27 inches: Dark brown, calcareous silt loam
27 inches: Basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 4 to 7 inches

Contrasting Inclusions

- Anderly, Kuhl, Nansene, and Ritzville soils

Major Uses

Dryland farming, livestock grazing

20D—Mikkalo silt loam, 15 to 35 percent north slopes

Composition

Mikkalo soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: North-facing side slopes
Landform: Canyons
Parent material: Loess over basalt
Elevation: 1,000 to 2,000 feet
Native plants: Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—9 to 11 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 12 inches: Very dark grayish brown and dark brown silt loam
12 to 27 inches: Dark brown, calcareous silt loam
27 inches: Basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 4 to 7 inches

Contrasting Inclusions

- Anderly, Kuhl, Nansene, and Ritzville soils

Major Use

Livestock grazing

21E—Nansene-Rock outcrop complex, 35 to 70 percent north slopes

Composition

Nansene soil and similar inclusions—50 percent
Rock outcrop—40 percent
Contrasting inclusions—10 percent

Setting

Landscape position: North-facing side slopes
Landform: Canyons
Parent material: Loess over basalt
Elevation: 200 to 2,600 feet
Native plants: Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—12 to 13 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Characteristics of the Nansene Soil

Typical Profile

0 to 37 inches: Very dark brown silt loam
37 to 54 inches: Dark brown silt loam
54 inches: Basalt

Properties and Qualities

Depth: Bedrock at a depth of 40 to 60 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 7 to 12 inches

Characteristics of the Rock Outcrop

Kind of material: Exposed bedrock, typically basalt

Contrasting Inclusions

- Anderly and Kuhl soils
- Lickskillet soils on south-facing slopes

Major Use

Livestock grazing

22A—Pedigo silt loam, 0 to 3 percent slopes

Composition

Pedigo soil and similar inclusions—90 percent
Contrasting inclusions—10 percent

Setting

Landform: Flood plains
Parent material: Alluvium
Elevation: 1,000 to 2,300 feet
Native plants: Black greasewood, basin wildrye, inland saltgrass
Climatic factors:
Mean annual precipitation—11 to 12 inches

Mean annual air temperature—48 to 50 degrees F
Frost-free period—100 to 150 days

Typical Profile

0 to 7 inches: Dark brown and very dark brown silt loam
7 to 35 inches: Black to dark gray silt loam
35 to 60 inches: Dark brown very fine sandy loam

Soil Properties and Qualities

Depth: Bedrock at a depth of more than 60 inches
Drainage class: Somewhat poorly drained
Depth to water table: 30 to 42 inches in January through April
Permeability: Moderate
Available water capacity: 10 to 12 inches
Frequency of flooding: Frequent in November through May

Contrasting Inclusions

- Hermiston and Endersby soils

Major Uses

Irrigated hay and pasture, livestock grazing

23C—Quincy loamy fine sand, 5 to 25 percent slopes

Composition

Quincy soil and similar inclusions—90 percent
Contrasting inclusions—10 percent

Setting

Landform: Terraces, dunes
Parent material: Eolian sand
Elevation: 200 to 400 feet
Native plants: Antelope bitterbrush, needleandthread, Indian ricegrass
Climatic factors:
Mean annual precipitation—12 to 13 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 15 inches: Dark brown loamy fine sand
15 to 60 inches: Very dark grayish brown loamy fine sand

Soil Properties and Qualities

Depth: Bedrock at a depth of more than 60 inches
Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: 4 to 6 inches

Contrasting Inclusions

- Wato soils
- Dunes
- Rock outcrop

Major Use

Livestock grazing

24B—Ritzville silt loam, 2 to 7 percent slopes

Composition

Ritzville soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Benches, ridgetops
Landform: Mesas
Parent material: Loess over basalt
Elevation: 1,000 to 2,000 feet
Native plants: Basin big sagebrush, bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—9 to 11 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 26 inches: Dark brown silt loam
26 to 45 inches: Dark yellowish brown and brown, calcareous silt loam
45 inches: Basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 40 to 60 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 7 to 12 inches

Contrasting Inclusions

- Lickskillet and Mikkalo soils

Major Uses

Dryland farming, livestock grazing

24C—Ritzville silt loam, 7 to 15 percent slopes

Composition

Ritzville soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Benches, ridgetops
Landform: Mesas
Parent material: Loess over basalt
Elevation: 1,000 to 2,000 feet
Native plants: Basin big sagebrush, bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—9 to 11 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 26 inches: Dark brown silt loam
26 to 45 inches: Dark yellowish brown and brown, calcareous silt loam
45 inches: Basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 40 to 60 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 7 to 12 inches

Contrasting Inclusions

- Lickskillet and Mikkalo soils

Major Uses

Dryland farming, livestock grazing

25A—Riverwash

Composition

Riverwash—85 percent
Contrasting inclusions—15 percent

Setting

Landform: Flood plains
Slope range: 0 to 2 percent
Parent material: Alluvium
Elevation: 200 to 2,500 feet
Climatic factors:
Mean annual precipitation—11 to 13 inches
Mean annual air temperature—48 to 51 degrees F
Frost-free period—100 to 150 days

Characteristics of the Riverwash

Kind of material: Deposits of gravel and soil material that do not support vegetation and are subject to inundation and deposition annually
Frequency of flooding: Frequent in November through May

Contrasting Inclusions

- Endersby and Hermiston soils

26E—Rock outcrop

Composition

Rock outcrop—90 percent
Contrasting inclusions—10 percent

Setting

Landscape position: Convex side slopes and shoulders
Landform: Canyons
Parent material: Basalt
Elevation: 200 to 2,800 feet
Climatic factors:
Mean annual precipitation—9 to 13 inches
Mean annual air temperature—48 to 51 degrees F
Frost-free period—100 to 150 days

Characteristics of the Rock Outcrop

Kind of material: Exposed bedrock, typically basalt

Contrasting Inclusions

- Lickskillet soils on south-facing slopes
- Kuhl, Nansene, and Wrentham soils on north-facing slopes

27E—Rock outcrop-Rubble land-Lickskillet complex, 50 to 80 percent south slopes

Composition

Rock outcrop—50 percent
Rubble land—25 percent

Lickskillet soil and similar inclusions—20 percent
Contrasting inclusions—5 percent

Setting

Landscape position: South-facing side slopes
Landform: Canyons
Parent material: Kind—residuum; source—basalt
Elevation: 200 to 2,800 feet
Native plants: Bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—11 to 13 inches
Mean annual air temperature—48 to 51 degrees F
Frost-free period—100 to 150 days

Characteristics of the Rock Outcrop

Kind of material: Exposed bedrock, typically basalt

Characteristics of the Rubble Land

Kind of material: Deposits of unconsolidated rock fragments, typically at base of rimrock

Characteristics of the Lickskillet Soil

Typical Profile

0 to 9 inches: Very dark grayish brown very stony loam
9 to 13 inches: Dark brown very gravelly loam
13 to 19 inches: Dark brown very gravelly clay loam
19 inches: Basalt

Properties and Qualities

Depth: Bedrock at a depth of 12 to 20 inches
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 1 to 3 inches

Contrasting Inclusions

- Bakeoven and Kuhl soils

Major Use

Wildlife habitat

28C—Sagemoor silt loam, 5 to 20 percent slopes

Composition

Sagemoor soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Side slopes
Landform: Dissected terraces
Parent material: Lacustrine deposits
Elevation: 300 to 1,500 feet
Native plants: Basin big sagebrush, bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—12 to 13 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 4 inches: Dark brown silt loam
4 to 24 inches: Dark brown and brown silt loam
24 to 84 inches: Brown, calcareous silt loam

Soil Properties and Qualities

Depth: Bedrock at a depth of more than 60 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 11 to 13 inches

Contrasting Inclusions

- Endersby, Hermiston, and Lickskillet soils

Major Use

Livestock grazing

29D—Sagemoor silt loam, 20 to 40 percent north slopes

Composition

Sagemoor soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: North-facing side slopes
Landform: Dissected terraces
Parent material: Lacustrine deposits
Elevation: 300 to 1,500 feet
Native plants: Basin big sagebrush, bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—12 to 13 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 4 inches: Dark brown silt loam
4 to 24 inches: Dark brown and brown silt loam
24 to 84 inches: Brown, calcareous silt loam

Soil Properties and Qualities

Depth: Bedrock at a depth of more than 60 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 11 to 13 inches

Contrasting Inclusions

- Nansene and Wrentham soils
- Rock outcrop

Major Use

Livestock grazing

30D—Sagemoor silt loam, 20 to 40 percent south slopes

Composition

Sagemoor soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: South-facing side slopes
Landform: Dissected terraces
Parent material: Lacustrine deposits
Elevation: 300 to 1,500 feet
Native plants: Bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—12 to 13 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 4 inches: Dark brown silt loam
4 to 24 inches: Brown silt loam
24 to 84 inches: Brown, calcareous silt loam

Soil Properties and Qualities

Depth: Bedrock at a depth of more than 60 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 11 to 13 inches

Contrasting Inclusions

- Lickskillet soils
- Rock outcrop

Major Use

Livestock grazing

31B—Walla Walla silt loam, 1 to 7 percent slopes

Composition

Walla Walla soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Benches, ridgetops
Landform: Mesas
Parent material: Loess
Elevation: 1,000 to 2,000 feet
Native plants: Idaho fescue, bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—12 to 13 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 17 inches: Very dark brown silt loam
17 to 60 inches: Dark brown silt loam

Soil Properties and Qualities

Depth: Bedrock at a depth of more than 60 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 11 to 13 inches

Contrasting Inclusions

- Ritzville and Wato soils

Major Uses

Dryland farming, livestock grazing

31C—Walla Walla silt loam, 7 to 15 percent slopes

Composition

Walla Walla soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Benches, ridgetops
Landform: Mesas

Parent material: Loess
Elevation: 1,000 to 2,000 feet
Native plants: Idaho fescue, bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—12 to 13 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 17 inches: Very dark brown silt loam
17 to 60 inches: Dark brown silt loam

Soil Properties and Qualities

Depth: Bedrock at a depth of more than 60 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 11 to 13 inches

Contrasting Inclusions

- Ritzville and Wato soils

Major Uses

Dryland farming, livestock grazing

32D—Walla Walla silt loam, 15 to 35 percent north slopes

Composition

Walla Walla soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: North-facing side slopes
Landform: Canyons
Parent material: Loess
Elevation: 1,000 to 2,000 feet
Native plants: Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—12 to 13 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 17 inches: Very dark brown silt loam
17 to 60 inches: Dark brown silt loam

Soil Properties and Qualities

Depth: Bedrock at a depth of more than 60 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 11 to 13 inches

Contrasting Inclusions

- Ritzville, Wato, and Wrentham soils

Major Use

Livestock grazing

33D—Walla Walla silt loam, 15 to 35 percent south slopes

Composition

Walla Walla soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: South-facing side slopes
Landform: Canyons
Parent material: Loess
Elevation: 1,000 to 2,000 feet
Native plants: Bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—12 to 13 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 15 inches: Very dark brown silt loam
15 to 52 inches: Dark brown silt loam
52 inches: Basalt

Soil Properties and Qualities

Depth: Bedrock at a depth of 40 to 60 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 7 to 12 inches

Contrasting Inclusions

- Lickskillet, Ritzville, and Wato soils

Major Use

Livestock grazing

34B—Wato very fine sandy loam, 3 to 7 percent slopes

Composition

Wato soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Benches, ridgetops
Landform: Mesas
Parent material: Loess
Elevation: 200 to 2,000 feet
Native plants: Needleandthread, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—12 to 13 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 13 inches: Very dark brown very fine sandy loam
13 to 60 inches: Dark brown very fine sandy loam

Soil Properties and Qualities

Depth: Bedrock at a depth of more than 60 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: 7 to 12 inches

Contrasting Inclusions

- Anders and Walla Walla soils

Major Uses

Dryland farming, livestock grazing

34C—Wato very fine sandy loam, 7 to 15 percent slopes

Composition

Wato soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: Benches, ridgetops
Landform: Mesas
Parent material: Loess
Elevation: 200 to 2,000 feet
Native plants: Needleandthread, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—12 to 13 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 13 inches: Very dark brown very fine sandy loam
13 to 60 inches: Dark brown very fine sandy loam

Soil Properties and Qualities

Depth: Bedrock at a depth of more than 60 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: 7 to 12 inches

Contrasting Inclusions

- Anders, Kuhl, and Walla Walla soils

Major Uses

Dryland farming, livestock grazing

35D—Wato very fine sandy loam, 15 to 35 percent north slopes

Composition

Wato soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: North-facing side slopes
Landform: Canyons
Parent material: Loess
Elevation: 200 to 2,000 feet
Native plants: Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—12 to 13 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 13 inches: Very dark brown very fine sandy loam
13 to 60 inches: Dark brown very fine sandy loam

Soil Properties and Qualities

Depth: Bedrock at a depth of more than 60 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: 7 to 12 inches

Contrasting Inclusions

- Anders, Kuhl, Nansene, and Walla Walla soils

Major Use

Livestock grazing

36D—Wato very fine sandy loam, 15 to 35 percent south slopes

Composition

Wato soil and similar inclusions—85 percent
Contrasting inclusions—15 percent

Setting

Landscape position: South-facing side slopes
Landform: Canyons
Parent material: Loess
Elevation: 200 to 2,000 feet
Native plants: Bluebunch wheatgrass, Sandberg bluegrass
Climatic factors:
Mean annual precipitation—12 to 13 inches
Mean annual air temperature—49 to 51 degrees F
Frost-free period—110 to 150 days

Typical Profile

0 to 13 inches: Very dark brown very fine sandy loam
13 to 60 inches: Dark brown very fine sandy loam

Soil Properties and Qualities

Depth: Bedrock at a depth of more than 60 inches
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: 7 to 12 inches

Contrasting Inclusions

- Anders, Lickskillet, and Walla Walla soils
- Rock outcrop

Major Use

Livestock grazing

37E—Wrentham-Rock outcrop complex, 35 to 70 percent north slopes

Composition

Wrentham soil and similar inclusions—50 percent
Rock outcrop—40 percent
Contrasting inclusions—10 percent

Setting

Landscape position: North-facing side slopes
Landform: Canyons
Parent material: Loess over basalt
Elevation: 200 to 2,800 feet
Native plants: Idaho fescue, bluebunch wheatgrass
Climatic factors:
Mean annual precipitation—11 to 13 inches
Mean annual air temperature—48 to 51 degrees F
Frost-free period—100 to 150 days

Characteristics of the Wrentham Soil

Typical Profile

0 to 12 inches: Very dark brown silt loam
12 to 17 inches: Dark brown silt loam
17 to 32 inches: Dark brown extremely cobbly silt loam
32 inches: Basalt

Properties and Qualities

Depth: Bedrock at a depth of 20 to 40 inches
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 3 to 6 inches

Characteristics of the Rock Outcrop

Kind of material: Exposed bedrock, typically basalt

Contrasting Inclusions

- Kuhl soils
- Lickskillet and Bakeoven soils on south-facing slopes

Major Use

Livestock grazing

38A—Xerolls, silty, 0 to 3 percent slopes

Composition

Xerolls and similar inclusions—90 percent
Contrasting inclusions—10 percent

Setting

Landscape position: Basins
Landform: Mesas
Parent material: Lacustrine sediment
Elevation: 2,550 to 2,600 feet
Native plants: Basin wildrye
Climatic factors:
Mean annual precipitation—11 to 12 inches
Mean annual air temperature—48 to 50 degrees F
Frost-free period—100 to 150 days

Representative Profile

0 to 11 inches: Very dark brown silt loam
11 to 40 inches: Dark brown silty clay loam
40 to 60 inches: Dark yellowish brown fine sandy loam

Soil Properties and Qualities

Depth: Bedrock at a depth of more than 60 inches
Drainage class: Somewhat poorly drained
Depth to water table: 12 to 36 inches in winter and spring
Permeability: Moderately slow
Available water capacity: 9 to 12 inches
Periods of ponding: Rare to frequent during snowmelt in spring

Contrasting Inclusions

- Cantala soils

Major Use

Dryland farming

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 to prevent 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 behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreational 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

General management needed for crops and pasture is suggested in this section. The estimated yields of the main crops, hay, and pasture plants are listed for each soil in table 5, the system of land capability classification used by the Natural Resources Conservation Service is explained, and prime farmland is described.

Sherman County has approximately 324,140 acres of land that has soil characteristics and climatic conditions favorable for crop production. About 300,000 acres is used for nonirrigated crops, mainly small grain.

The dominant nonirrigated crop rotation used in the county is a grain-fallow system. Winter wheat and spring barley are grown most commonly. The soil is kept free of vegetation, or fallowed, during one growing season to store soil moisture and control weeds prior to planting small grain in fall or spring. This rotation system is used in areas of Anderly, Anders, Cantala, Condon, Mikkalo, Ritzville, Walla Walla, and Wato soils that do not receive adequate rainfall to grow crops annually. Erosion by water and wind and inadequate moisture for plant growth are limitations in areas where a grain-fallow system is used.

The majority of the soils used for nonirrigated crops are silt loam and are very susceptible to sheet, rill, and ephemeral gully erosion caused by runoff. The hazard of water erosion is greatest in winter in areas where winter wheat is planted in a frozen soil that has been fallowed. Subfreezing temperatures freeze the soil surface. Rainfall or snowmelt cannot infiltrate these soils; thus, it runs off and detaches soil particles causing serious erosion and loss of topsoil. It is common for several cycles of freezing and thawing to occur during a normal winter in Sherman County. Soils that are particularly subject to runoff and erosion caused by freezing and thawing are those of the Anderly, Anders, Cantala, Condon, Mikkalo, Ritzville, Walla Walla, and Wato series that have slopes of more than 10 percent.

Soil quality and the potential soil productivity are reduced as organic matter and plant nutrients are lost through erosion. Soil structure and tilth also deteriorate, reducing the water infiltration rate and moisture holding capacity of the soil. The severity of the erosion determines how much of the potential soil productivity is lost and for how long. It takes many years to rebuild a soil and its productivity even if the best soil-building crop rotations are used.

Poor management and lack of conservation practices can increase the potential for soil erosion from runoff on soils that are subject to freezing and thawing. Practices that increase the potential for runoff and erosion include removing crop residue after harvest by excessive grazing, mechanical means, or burning and burying all residue below the soil surface by tilling. These practices eliminate the protective cover provided by crop residue.

Year-round management of crop residue to reduce runoff and erosion involves several practices. The main goal of these practices is to leave as much plant material as possible on the soil surface throughout the year. Using tillage operations during the fallow season that leave residue on the soil surface and incorporate residue into the upper 4 inches of the soil provides a protective cover that reduces soil erosion and prevents loss of soil moisture. Nonselective herbicides commonly are used to control weeds and reduce the number of tillage operations needed. This reduces the deep burial of residue and allows more residue to be left on the soil surface after seeding small grain in fall. The residue reduces soil particle detachment by water and helps to filter out sediment from the runoff (fig. 3).

Figure 3.—Crop residue management in an area used for winter wheat.

Organic matter from crop residue is an important source of nitrogen, phosphorus, and other nutrients needed by plants. It also maintains or increases the water infiltration rate, water holding capacity, and soil tilth. Poor soil tilth combined with excessive tillage when the soils are wet can result in soil compaction, which reduces water infiltration and restricts plant growth. Mulch tillage systems that limit the number of operations and leave residue on or near the soil surface can maintain or improve the health of the soil.

In addition to crop residue management, additional conservation practices are needed in many areas to reduce water erosion. In areas that have long slopes or where runoff concentrates, structural practices such as use of terraces, diversions, and grassed waterways may be needed. Other suitable practices may include tilling on the contour, seeding, and stripcropping.

Terraces and diversions are constructed across the slope to reduce the length of the slope, thereby redirecting runoff, trapping sediment, and reducing erosion (fig. 4). Terraces are most practical in areas of soils that have uniform slopes, and they are most effective in reducing erosion in areas that have slopes of less than 12 percent.

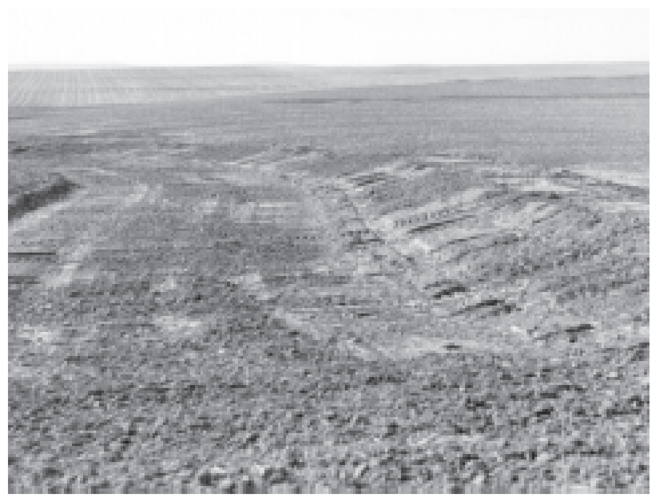


Figure 4.—Newly constructed level terraces in an area of Walla Walla silt loam, 7 to 15 percent slopes.

Level and gradient terraces are constructed on the nonirrigated cropland in the area. Level terraces are preferred and generally are more effective on deep soils such as those of the Cantala, Walla Walla (see fig. 5, next page), and Wato series. Gradient terraces generally are constructed on moderately deep soils such as those of the Anderly, Anders, and Condon soils.

Grassed waterways are effective in reducing erosion and sedimentation in areas of concentrated runoff (see fig. 6, next page). These waterways can be established in areas where there is a natural or constructed channel and a suitable outlet. Adapted vegetation, usually sod-forming grasses, is planted to reduce the velocity of the runoff and to make the soil more resistant to erosion. The grasses also act as a filter, thus reducing the amount of sediment carried by runoff.

Figure 5.—Nearly level terraces in an area of Walla Walla silt loam, 7 to 15 percent slopes.

Figure 6.—Grassed waterway in an area of Walla Walla soil.

Contour tillage and seeding create ridges or furrows across the slope to redirect runoff and reduce erosion. These practices are best suited to soils that have smooth, uniform slopes. The more gently sloping areas of the Condon and Walla Walla soils are examples.

Stripcropping consists of planting alternate strips of fall grain with strips of fallowed crop residue to provide alternating protected and erosion-prone strips across the slope. Stripcropping reduces water erosion by trapping sediment in the protected strips. It also conserves moisture by trapping snow in the fallowed strips in winter. The moisture infiltrates the soil and is available for plant growth.

Areas that have steep slopes, particularly those that have slopes of more than 25 percent, are highly susceptible to water erosion. These include the steeper areas of the Anderly, Condon, Mikkalo, Walla Walla, and Wato soils. These areas may need to be planted to permanent vegetation to reduce runoff and erosion.

On moderately deep soils, such as those of the Anderly, Anders, and Condon series, where the soil profile commonly is filled by the precipitation received in one season, annual cropping may reduce soil erosion. When precipitation is higher than normal, some deep soils can be cropped 2 or 3 years in a row followed by a year of fallow.

In the drier areas of the Anderly, Cantala, Condon, and Walla Walla soils, wind erosion can be a limitation at planting time early in spring and fall in areas used as fallow. Mulch tillage systems that keep a cover of residue on the soil surface are effective in reducing soil detachment by wind. Stripcropping with alternating strips of stubble and small grain perpendicular to the prevailing wind also reduces wind erosion.

Soils, such as those of the Endersby, Hermiston, and Pedigo series, that are on flood plains and terraces where annual precipitation is supplemented by subsurface water commonly are used to grow permanent grass or grass-legume pasture. Proper management includes balancing livestock populations with the available forage and timing the grazing period to meet the physiological needs of the plants and the nutritional needs of the animals.

To maintain crop production and quality, a nutrient management program is needed on all soils in the county. This includes management of crop residue, crop rotation, and application of fertilizer to maintain, supplement, or replace the soils' supply of elements required for plant nutrition. Elements that affect plant growth throughout the nonirrigated cropland include nitrogen, phosphorus, and sulfur. Nutrient management should be based on the results of soil tests, realistic crop yield goals, and the objectives of the operator. The local office of the County Extension Service can assist in determining the kind and amount of plant nutrients to apply.

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. Yields for nonirrigated winter wheat and barley are based on a rotation of cropping one year and then fallowing one year; therefore, the expected yields are for a two-year period. In any given year when crops are grown, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit or soil component also is shown in the table.

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; and harvesting that ensures the smallest possible loss.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown, that good-quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

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 criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include 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.

Capability classes, the broadest groups, are designated by 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 hazard is the 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.

The capability classification of each map unit is given in table 5.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. It could be cultivated land, pastureland, forest land, or other land, but it is not urban or built-up land or water areas. The soil qualities, growing season, and moisture supply are those needed for the soil to economically produce sustained high yields of crops when proper management, including water management, and acceptable farming methods are applied. In general, prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, an acceptable salt and sodium content, and few or no rocks. It is permeable to water and air. It is not excessively erodible or saturated with water for long periods, and it either is not frequently flooded during the growing season or is protected from flooding. The slope ranges mainly from 0 to 7 percent. More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service.

About 210,000 acres, or nearly 40 percent, of the county would meet the requirements for prime farmland if an adequate and dependable supply of irrigation water were available.

A recent trend in land use in some parts of the survey area has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the survey area that are considered prime farmland are listed at the end of this section. This list does not constitute a recommendation for a particular land use. On some soils included in the list, measures that overcome a hazard or limitation, such as flooding, wetness, and droughtiness, are needed. Onsite evaluation is needed to determine whether or not the hazard or limitation has been overcome by corrective measures. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

The map units that meet the requirements for prime farmland if irrigated are:

1B Anderly silt loam, 1 to 7 percent slopes
4B Anders very fine sandy loam, 3 to 7 percent slopes
7B Cantala silt loam, 1 to 7 percent slopes
8B Condon silt loam, 1 to 7 percent slopes
11A Endersby fine sandy loam, 0 to 3 percent slopes
12A Endersby-Hermiston complex, 0 to 3 percent slopes
13A Hermiston silt loam, 0 to 3 percent slopes
19B Mikkalo silt loam, 2 to 7 percent slopes
22A Pedigo silt loam, 0 to 3 percent slopes
24B Ritzville silt loam, 2 to 7 percent slopes
31B Walla Walla silt loam, 1 to 7 percent slopes
34B Wato very fine sandy loam, 3 to 7 percent slopes
38A Xerolls, silty, 0 to 3 percent slopes

Rangeland

About 225,000 acres, or 42 percent, of Sherman County is rangeland. Bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass comprise about 90 percent of the potential native plant community.

Natural plant communities that meet their potential for grazing are common because a cropping system of wheat and summer fallow is used in many areas and cultivation is deferred every other year. Productivity of the rangeland can be maintained or improved by using management that is effective for specific kinds of soil and plant communities (see fig. 7, next page).

About 163,000 acres, or 72 percent, of the rangeland in the county needs to be improved. Of this, about 80,000 acres, or 35 percent, is in poor condition and plant cover needs to be reestablished. About 83,000 acres, or 37 percent, is in fair condition and can be improved through proper grazing management. This can be accomplished by using a deferred grazing system and by maintaining the proper season of use.

Figure 7.—Area of Condon soil that has been seeded to improve the range.

The forage on the private rangeland of some ranches is supplemented by forage from Federal rangeland available under a permit system. In fall and winter, grain stubble and hay are used to supplement forage from rangeland.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 6 shows, for each soil that supports rangeland vegetation suitable for grazing, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. An explanation of the column headings in the table follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre of air-dry vegetation. Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as exposure, amount of shade, recent rains, and unseasonable dry periods.

Characteristic vegetation—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *composition*, the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Windbreaks and Environmental Plantings

By Craig Ziegler, forester, Natural Resources Conservation Service.

Wind can be a serious environmental and economic concern. It can cause soil erosion, crop damage, safety hazards, and energy loss. Windbreaks offer landowners an effective way to reduce the effects of uncontrolled wind.

Field windbreaks protect crops, reduce soil erosion, and control blowing snow. These windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across a field. Significant increases in yields can be expected from crops protected by properly designed and maintained field windbreaks. Many environmental changes occur on the leeward side of windbreaks, including reduced windspeed, decreased transpiration by plants, increased humidity, decreased evaporation, and increased soil moisture.

Farmstead windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens and furnish habitat for wildlife. Several rows of low- and high-growing shrubs and trees provide the best 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.

For windbreaks to be effective, the species of trees or shrubs selected must be adapted to the soils. Permeability, available water capacity, fertility, and depth are soil characteristics that greatly effect the growth of trees and shrubs.

In this county, moisture is the main limitation to the survival of trees and shrubs. Properly preparing the site prior to planting and controlling competing vegetation after planting are essential when establishing new windbreaks. Replanting during the first 3 to 5 years may be necessary to ensure the establishment of fully stocked, effective windbreaks. Permanent irrigation by drip systems or other irrigation methods can be used to overcome moisture deficits. Irrigation is needed for healthier, denser, and faster growing windbreaks.

Weed control is very important for newly planted windbreaks. If weeds are not controlled, seedling mortality could be very high or early growth rates of planted seedlings could be substantially reduced. Weeds can be controlled by mechanical means or by applying herbicides. Synthetic weed barriers can also be used. These barriers are laid down after the tree or shrub seedlings are planted. They provide weed control within the rows for at least 3 to 5 years. The barriers also act as good mulch, which aids in conserving moisture and reducing extremes in soil temperature.

Each tree or shrub species has certain climatic and physiographic limits. Within these limits, trees or shrubs can be well suited or poorly suited to use as windbreaks because of specific soil characteristics. Windbreak suitability groups can be used as a guide for selecting the most suitable species for different kinds of soils and for predicting the growth and effectiveness of windbreaks. These groups can be helpful in selecting plants for windbreaks; recreational, wildlife, ornamental, and environmental plantings; reforestation; and critical area plantings.

All of the soils in the county have been grouped according to their suitability for growing trees and shrubs. These groups are described in the following paragraphs.

*Conservation Tree/Shrub Group 1.*The soils in this group are deep or very deep and are loamy (less than 35 percent clay). They are somewhat poorly drained, moderately well drained, or well drained. The water table during the growing season is at a depth of 36 inches or more. The available water capacity is 7.5 inches or more. The upper 12 inches of these soils does not have free carbonates, has reaction (pH) of as high as 7.8, and is nonsaline. Xerolls are in this group.

Conservation Tree/Shrub Group 3. The soils in this group are deep or very deep and are moderately well drained or well drained. Most of the soils are loamy (less than 35 percent clay), but some are clayey with a loamy surface mantle more than 20 inches thick. The soils in this group do not have a seasonal high water table within a depth of 36 inches of the surface. The available water capacity is 7.5 inches or more. The upper 12 inches of these soils does not have free carbonates, has reaction (pH) of as high as 7.8, and is nonsaline. Cantala, Nansene, Walla Walla, and Wato soils are in this group.

Conservation Tree/Shrub Group 5. The soils in this group are deep or very deep and are loamy to loamy-skeletal. They are somewhat poorly drained, moderately well drained, or well drained. These soils may be subject to flooding. The water table during the growing season is at a depth of 36 inches or more. The available water capacity is 4.0 to 7.5 inches. The upper 12 inches of these soils does not have free carbonates, has reaction (pH) of as high as 7.8, and is nonsaline. Endersby soils are in this group.

Conservation Tree/Shrub Group 5K. The soils in this group are deep or very deep and are loamy to loamy-skeletal. They are somewhat poorly drained, moderately well drained, or well drained. These soils may be subject to flooding. The water table during the growing season is at a depth of 36 inches or more. The available water capacity is 4.0 to 7.5 inches. These soils have 5 to 15 percent free carbonates at a depth of 20 to 40 inches, have reaction (pH) of 7.8 to 8.4, and are nonsaline. Ritzville and Sagemoor soils are in this group.

Conservation Tree/Shrub Group 6D. The soils in this group are moderately deep and are loamy, clayey-skeletal, or loamy-skeletal. They are moderately well drained, well drained, or somewhat excessively drained. These soils may be subject to flooding. The water table during the growing season is at a depth of 36 inches or more. The available water capacity is 4 inches or more. The upper 12 inches of these soils does not have free carbonates, has reaction (pH) of as high as 7.8, and is nonsaline. Anderly, Anders, Condon, and Wrentham soils are in this group.

Conservation Tree/Shrub Group 6G. The soils in this group are moderately deep to very deep and are loamy, clayey-skeletal, or loamy-skeletal over sand and gravel. These soils are moderately well drained, well drained, or somewhat excessively drained. The available water capacity is more than 4 inches. The upper 12 inches of these soils does not have free carbonates, has reaction (pH) of as high as 7.8, and has electrical conductivity of less than 2 millimhos per centimeter. Endersby soils are in this group.

Conservation Tree/Shrub Group 6DK. The soils in this group are moderately deep and are loamy, clayey-skeletal, or loamy-skeletal over an impervious layer. They are moderately well drained, well drained, or somewhat excessively drained. The available water capacity is more than 4 inches. These soils have 5 to 15 percent free carbonates at a depth of 20 to 40 inches, have reaction (pH) of 7.8 to 8.4, and are nonsaline. Mikkalo soils are in this group.

Conservation Tree/Shrub Group 7. The soils in this group are deep or very deep and are sandy throughout (includes arenic and gross arenic subgroups). These soils are well drained, somewhat excessively drained, or excessively drained. The water table during the growing season is at a depth of 36 inches or more. The available water capacity is 2 inches or more. The upper 12 inches of these soils does not have free carbonates, has reaction (pH) of as high as 7.8, and is nonsaline. Quincy soils are in this group.

Conservation Tree/Shrub Group 8. The soils in this group are deep or very deep, loamy, and moderately well drained or well drained. The available water capacity is more than 7.5 inches. These soils have 5 to 15 percent free carbonates at a depth of 20 to 30 inches, have reaction (pH) of 7.8 to 8.4, and have electrical conductivity of less than 4 millimhos per centimeter. Hermiston soils are in this group.

Conservation Tree/Shrub Group 9W. The soils in this group are moderately deep to very deep. They have a water table at a depth of 18 to 60 inches and are subject to flooding or ponding. They are moderately well drained, somewhat poorly drained, or poorly drained. Electrical conductivity in the upper 12 inches is 4 to 16 millimhos per centimeter. Pedigo soils are in this group.

Conservation Tree/Shrub Group 10. The soils in this group have one or more characteristics, such as depth, texture, drainage, available water capacity, or salts, that severely limit the planting, survival, and growth of trees and shrubs. Examples include very shallow and shallow soils, soils that have a very low available water capacity (less than 2 inches), very poorly drained or poorly drained soils that are saturated or ponded throughout the growing season, and soils that contain toxic salts. The soils in this group generally are not suitable for farmstead, feedlot, or field windbreaks; however, onsite investigation may reveal that trees and shrubs can be planted with the use of special treatment such as irrigation and leaching of salts. The species selected for planting should be suited to the altered soil conditions. Bakeoven, Kuhl, and Lickskillet soils are in this group.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in the table 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 the local office of the Natural Resources Conservation Service or of the Cooperative Extension Service or from a commercial nursery.

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. Ratings are given for 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 should 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 or 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 kinds 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 evaluate the potential of areas for residential, commercial, industrial, and recreational uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and 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 8 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and depth to the water table.

Dwellings 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 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, shrinking and swelling, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material;

a base of gravel, crushed rock, or stabilized soil material; and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Sanitary Facilities

Table 9 shows the degree and kind of soil limitations that affect septic tank absorption fields 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.

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

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

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

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 should be considered.

The ratings in the table are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench 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 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 wind erosion.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as the 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 10 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 to 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, a 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 a 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 have a water table at a depth of 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. They are used in many kinds of construction. Specifications for each use vary widely. In the table, 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 high 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 11 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; embankments, dikes, and levees; and aquifer-fed excavated ponds. 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 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.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water as inferred from the salinity of the soil. Depth to bedrock and the content of large stones affect the ease of excavation.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to control erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind erosion or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts and 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 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 testing of some benchmark soils. Established standard procedures are followed. During the survey, shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps.

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 to characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, 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 12 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 the heading “Taxonomic Units 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 about 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, CL-ML.

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.

Rock fragments 3 to 10 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 field examination.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 13 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, 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 and septic tank absorption fields.

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. 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.

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 classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; *high*, more than 6 percent; and *very high*, greater than 9 percent.

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, rock fragments, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.02 to 0.64. Other factors being equal, 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. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible. The groups are as follows:

1. Coarse sands, sands, fine sands, and very fine sands.
2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, ash material, and sapric soil material.
3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay.
5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material.
6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay.
7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material.
8. Soils that are not subject to wind erosion because of coarse fragments on the surface or because of surface wetness.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In the table, 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 in 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 14 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, 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 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.

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 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 the 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 results in a severe hazard of corrosion. 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.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(4, 7)*. 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 15 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Eleven 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 Xeroll (*Xer*, meaning dry, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; type of saturation; 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 Haploxerolls (*Haplo*, meaning minimal horizonation, plus *Xeroll*, the suborder of the Mollisols that has a Xeric moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic subgroup 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 taxonomic class. 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 Haploxerolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle size, mineral content, soil temperature regime, soil depth, and reaction. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is coarse-silty, mixed, mesic Typic Haploxerolls.

SERIES. The series consists of soils within a family that have horizons similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile.

Taxonomic Units and Their Morphology

In this section, each taxonomic unit recognized in the survey area is described. Characteristics of the soil and the material in which it formed are identified for each unit. A pedon, a small three-dimensional area of soil, that is typical of the unit in the survey area is described. The detailed description of each soil horizon follows standards in the “Soil Survey Manual” *(5)*. Many of the technical terms used in the descriptions are defined in “Soil Taxonomy” *(7)* and in “Keys to Soil Taxonomy” *(4)*. Unless otherwise indicated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the unit.

The map units of each taxonomic unit are described in the section “Detailed Soil Map Units.”

Anderly Series

The Anderly series consists of moderately deep, well drained soils on mesas and canyons. The soils formed in loess over basalt. Slopes are 1 to 35 percent. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Anderly silt loam, 1 to 7 percent slopes; about 400 feet east of county road, 1,800 feet east and 550 feet north of the southwest corner of sec. 3, T. 1 S., R. 17 E.

Ap1—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine interstitial pores; neutral (pH 6.6); abrupt smooth boundary.

Ap2—8 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak thick platy structure parting to weak fine granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral (pH 6.8); abrupt smooth boundary.

Bw1—10 to 18 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine and fine tubular pores; neutral (pH 7.0); clear smooth boundary.

Bw2—18 to 30 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral (pH 7.2); abrupt wavy boundary.

2R—30 inches; basalt.

The depth to bedrock ranges from 20 to 40 inches.

The Ap horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry.

The Bw horizon has value of 3 or 4 when moist and 5 or 6 when dry, and it has chroma of 2 or 3 when moist or dry. It is neutral or mildly alkaline.

Anders Series

The Anders series consists of moderately deep, well drained soils on mesas and canyons. The soils formed in loess over basalt. Slopes are 3 to 35 percent. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Anders very fine sandy loam, 3 to 7 percent slopes; about 200 feet south of county road, 2,400 feet north and 1,350 feet east of the southwest corner of sec. 12, T. 2 N., R. 16 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) very fine sandy loam, grayish brown (10YR 5/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; few very fine interstitial pores; neutral (pH 6.6); abrupt smooth boundary.

A—8 to 13 inches; very dark grayish brown (10YR 3/2) very fine sandy loam, brown (10YR 5/3) dry; weak very fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine roots; few very fine and fine interstitial pores; neutral (pH 6.8); clear smooth boundary.

Bw—13 to 33 inches; dark brown (10YR 4/3) very fine sandy loam, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine roots; common very fine and fine interstitial pores; neutral (pH 7.0); abrupt smooth boundary.

2R—33 inches; basalt.

The depth to bedrock ranges from 20 to 40 inches.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry. It is neutral or mildly alkaline.

The Bw horizon has value of 3 or 4 when moist and 5 or 6 when dry, and it has chroma of 3 or 4 when moist or dry. The horizon is very fine sandy loam, silt loam, or gravelly silt loam. It is neutral to moderately alkaline.

Bakeoven Series

The Bakeoven series consists of very shallow, well drained soils on mesas. The soils formed in residuum derived from basalt. Slopes are 2 to 20 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 50 degrees F.

Typical profile of Bakeoven very stony loam, 2 to 20 percent slopes; about 1,250 feet west and 1,350 feet north of the southeast quarter corner of sec. 6, T. 4 S., R. 15 E.

A—0 to 2 inches; dark brown (7.5YR 3/2) very stony loam, brown (7.5YR 5/3) dry; weak thin platy structure parting to weak fine granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots and few fine roots; many fine interstitial pores; 20 percent gravel, 15 percent cobbles, and 20 percent stones; slightly acid (pH 6.5); abrupt smooth boundary.

Bw1—2 to 5 inches; dark brown (10YR 3/3) very cobbly loam, brown (7.5YR 5/3) dry; weak thin platy structure parting to weak fine and medium granular; slightly hard, friable, sticky and plastic; many very fine roots and few fine roots; common fine interstitial and tubular pores; 20 percent gravel, 20 percent cobbles, and 10 percent stones; neutral (pH 6.8); abrupt smooth boundary.

Bw2—5 to 7 inches; dark yellowish brown (10YR 3/4) very cobbly loam, yellowish brown (10YR 5/4) dry; moderate fine subangular blocky structure; hard, firm, sticky and plastic; many very fine roots and few fine roots; few fine tubular pores; 20 percent gravel, 30 percent cobbles, and 5 percent stones; neutral (pH 6.9); abrupt wavy boundary.

R—7 inches; basalt.

The depth to bedrock ranges from 4 to 10 inches. The profile has hue of 7.5YR or 10YR.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist and 2 to 4 when dry. The horizon is slightly acid to mildly alkaline.

The Bw horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist and 2 to 4 when dry. The horizon is very gravelly clay loam, very gravelly loam, or very cobbly loam. It is neutral or mildly alkaline.

Cantala Series

The Cantala series consists of very deep, well drained soils on mesas. The soils formed in loess. Slopes are 1 to 15 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Cantala silt loam, 1 to 7 percent slopes; about 150 feet north of county road, 550 feet east and 150 feet north of the southwest corner of sec. 30, T. 2 S., R. 17 E.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine vesicular pores; neutral (pH 6.6); abrupt smooth boundary.

A—9 to 15 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; many very fine vesicular pores; neutral (pH 6.6); gradual smooth boundary.

Bw1—15 to 31 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; many very fine and fine pores; neutral (pH 6.9); gradual smooth boundary.

Bw2—31 to 60 inches; dark brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine pores; neutral (pH 7.1); abrupt wavy boundary.

2R—60 inches; basalt.

The depth to bedrock is more than 60 inches. The content of organic matter is less than 1 percent below a depth of 15 inches.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry.

The Bw horizon has value of 3 or 4 when moist and 5 or 6 when dry, and it has chroma of 3 or 4 when moist or dry.

Condon Series

The Condon series consists of moderately deep, well drained soils on mesas and canyons. The soils formed in loess over basalt. Slopes are 1 to 35 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Condon silt loam, 1 to 7 percent slopes; 2,400 feet north and 150 feet west of the southeast corner of sec. 5, T. 3 S., R. 17 E.

A1—0 to 3 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak medium platy structure parting to weak medium granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; common fine interstitial pores; neutral (pH 6.6); abrupt smooth boundary.

A2—3 to 12 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common fine tubular pores; neutral (pH 6.7); clear smooth boundary.

Bw1—12 to 19 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common fine tubular pores; neutral (pH 6.8); gradual smooth boundary.

Bw2—19 to 30 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak coarse prismatic structure parting to weak fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common fine tubular pores; neutral (pH 7.2); abrupt smooth boundary.

2R—30 inches; basalt.

The depth to bedrock is 20 to 40 inches. The content of organic matter is less than 1 percent below a depth of 12 inches.

The A horizon has value of 4 or 5 when dry and chroma of 2 or 3 when moist or dry. It is slightly acid or neutral.

The Bw horizon has value of 3 or 4 when moist and 5 or 6 when dry. It is slightly acid to mildly alkaline.

Endersby Series

The Endersby series consists of very deep, somewhat excessively drained soils on terraces. The soils formed in alluvium. Slopes are 0 to 3 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Endersby fine sandy loam in an area of Endersby-Hermiston complex, 0 to 3 percent slopes; about 1,200 feet north of Harmony; 2,000 feet west and 1,600 feet north of the southeast quarter corner of sec. 30, T. 1 S., R. 18 E.

A1—0 to 16 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak medium granular structure parting to weak medium subangular blocky; slightly hard, very friable, nonsticky and nonplastic; many very fine roots and common fine roots; many fine interstitial pores; neutral (pH 7.2); clear wavy boundary.

A2—16 to 25 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many fine interstitial pores; mildly alkaline (pH 7.6); clear wavy boundary.

Bw—25 to 31 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine roots and few fine roots; many fine interstitial pores; 10 percent subangular rounded gravel; mildly alkaline (pH 7.6); clear smooth boundary.

2BC—31 to 40 inches; very dark grayish brown (10YR 3/2) very gravelly sand, brown (10YR 5/3) dry; massive; soft, very friable, nonsticky and nonplastic; many very fine roots and few fine roots; many fine interstitial pores; 50 percent subangular rounded gravel; mildly alkaline (pH 7.6); clear smooth boundary.

2C—40 to 60 inches; very dark grayish brown (10YR 3/2) and black (10YR 2/1) extremely gravelly sand, multicolored (10YR 7/1 to 5/2 and 10YR 2/1) dry; single grain; loose, nonsticky and nonplastic; common very fine roots; many fine and medium interstitial pores; 70 percent subangular rounded gravel; mildly alkaline (pH 7.6).

The depth to sand and gravel is 30 to 60 inches. The profile is neutral to moderately alkaline throughout. The content of organic matter decreases irregularly as depth increases. The mollic epipedon is 30 to 50 inches thick.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry.

The Bw horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry. The horizon is fine sandy loam or loam.

The 2BC and 2C horizons have value of 5 to 7 when dry and chroma of 2 or 3 when moist and 1 to 3 when dry. They are stratified very gravelly sand and extremely gravelly sand. The total content of rock fragment ranges from 50 to 80 percent.

Hermiston Series

The Hermiston series consists of very deep, well drained soils on flood plains. The soils formed in alluvium. Slopes are 0 to 3 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Hermiston silt loam in an area of Endersby-Hermiston complex, 0 to 3 percent slopes; northwest of Kenneth Spring; about 2,500 feet east and 300 feet south of the northwest corner of sec. 10, T. 1 S., R. 17 E.

A1—0 to 8 inches; dark brown (10YR 3/3) silt loam, grayish brown (10YR 5/2) dry; weak thick platy structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine interstitial pores; mildly alkaline (pH 7.4); clear smooth boundary.

A2—8 to 21 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine interstitial pores; mildly alkaline (pH 7.8); clear smooth boundary.

2Bk1—21 to 26 inches; dark grayish brown (10YR 4/2) very fine sandy loam, light gray (10YR 7/2) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine roots and few fine roots; many very fine interstitial pores; strongly effervescent with disseminated and segregated mycelial lime; moderately alkaline (pH 8.4); clear wavy boundary.

2Bk2—26 to 37 inches; dark brown (10YR 4/3) very fine sandy loam, light brownish gray (10YR 6/2) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; many fine tubular pores; slightly effervescent with disseminated lime; moderately alkaline (pH 8.4); clear wavy boundary.

3C—37 to 60 inches; dark brown (10YR 4/3) silt loam, light gray (10YR 7/2) dry; massive; slightly hard, friable, slightly sticky and nonplastic; few fine roots; many fine vesicular pores; moderately alkaline (pH 8.4).

The depth to bedrock is more than 60 inches. The depth to secondary lime is 20 to 30 inches. The mollic epipedon is 20 to 30 inches thick. The content of organic matter decreases irregularly as depth increases.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 1 to 3 when moist or dry. The horizon is neutral to moderately alkaline.

The 2Bk and 3C horizons have value of 3 or 4 when moist and 6 or 7 when dry, and they have chroma of 2 or 3 when moist or dry. The horizons are silt loam or very fine sandy loam. They are mildly alkaline to strongly alkaline.

Kuhl Series

The Kuhl series consists of shallow, well drained soils on canyons. The soils formed in loess over basalt. Slopes are 3 to 40 percent. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Kuhl very stony very fine sandy loam in an area of Kuhl-Rock outcrop complex, 20 to 40 percent north slopes; about 1,500 feet east and 2,400 feet south of the northwest corner of sec. 6, T. 2 N., R. 17 E.

A1—0 to 5 inches; very dark grayish brown (10YR 3/2) very stony very fine sandy loam, grayish brown (10YR 5/2) dry; weak thin platy structure parting to weak fine granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots and common fine roots; common very fine tubular pores; 5 percent gravel, 30 percent cobbles, and 20 percent stones; neutral (pH 6.8); abrupt smooth boundary.

A2—5 to 12 inches; dark brown (10YR 3/3) stony silt loam, brown (10YR 5/3) dry; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots and few fine roots; many very fine tubular pores and common fine tubular pores; 5 percent gravel, 15 percent cobbles, and 10 percent stones; neutral (pH 7.0); clear smooth boundary.

Bw—12 to 17 inches; dark brown (10YR 4/3) stony silt loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; slightly hard, friable, sticky and plastic; common very fine roots and few fine roots; common very fine tubular pores; 5 percent gravel, 10 percent cobbles, and 10 percent stones; neutral (pH 7.0); abrupt wavy boundary.

2R—17 inches; basalt.

The depth to bedrock ranges from 10 to 20 inches. The profile is neutral or mildly alkaline throughout. The content of rock fragments in the particle-size control section averages 20 to 35 percent.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry.

The Bw horizon has value of 3 or 4 when moist and 5 or 6 when dry, and it has chroma of 3 or 4 when moist or dry. The horizon is stony silt loam, cobbly loam, or gravelly silt loam.

Lickskillet Series

The Lickskillet series consists of shallow, well drained soils on canyons. The soils formed in residuum derived from basalt. Slopes are 2 to 80 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Lickskillet very stony loam in an area of Lickskillet-Rock outcrop complex, 40 to 70 percent south slopes, about 200 feet downslope from State Road 216; about 50 feet east and 1,500 feet south of the northwest corner of sec. 6, T. 4 S., R. 15 E.

A—0 to 9 inches; very dark grayish brown (10YR 3/2) very stony loam, brown (10YR 5/3) dry; weak thin platy structure parting to weak fine granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine interstitial pores; 20 percent gravel, 10 percent cobbles, and 20 percent stones; neutral (pH 6.9); clear wavy boundary.

Bw1—9 to 13 inches; dark brown (7.5YR 3/4) very gravelly loam, brown (7.5YR 5/4) dry; moderate fine and medium subangular blocky structure; hard, very firm, sticky and plastic; common very fine roots; common very fine tubular pores; 30 percent gravel and 20 percent cobbles; neutral (pH 6.8); clear wavy boundary.

Bw2—13 to 19 inches; dark brown (7.5YR 3/4) very gravelly clay loam, brown (7.5YR 5/4) dry; moderate fine and medium subangular blocky structure; hard, very firm, sticky and plastic; common very fine roots; common very fine tubular pores; 40 percent gravel and 15 percent cobbles; neutral (pH 6.6); abrupt wavy boundary.

R—19 inches; basalt.

The depth to bedrock ranges from 12 to 20 inches.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry. The horizon is slightly acid or neutral.

The Bw horizon has hue of 10YR or 7.5YR, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist or dry. The horizon is very gravelly clay loam, very gravelly loam, or very cobbly loam. It is 35 to 60 percent rock fragments. It is neutral to moderately alkaline.

Mikkalo Series

The Mikkalo series consists of moderately deep, well drained soils on mesas and canyons. The soils formed in loess over basalt. Slopes are 2 to 35 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Mikkalo silt loam, 2 to 7 percent slopes, about 300 feet east of road; 300 feet east and 2,500 feet south of the northwest corner of sec. 9, T. 1 N., R. 19 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots; few very fine vesicular pores; neutral (pH 6.8); abrupt smooth boundary.

A—8 to 12 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; few very fine vesicular pores; neutral (pH 6.8); clear smooth boundary.

Bk1—12 to 24 inches; dark brown (10YR 3/3) silt loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine and fine vesicular pores; slightly effervescent; neutral (pH 7.2); clear smooth boundary.

Bk2—24 to 27 inches; dark brown (10YR 4/3) silt loam, very pale brown (10YR 7/3) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine roots; few very fine vesicular pores; strongly effervescent with few segregated filaments of lime; mildly alkaline (pH 7.6); abrupt smooth boundary.

2R—27 inches; basalt.

The depth to bedrock ranges from 20 to 40 inches. The depth to secondary carbonates is 20 to 30 inches.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry. The horizon is neutral or mildly alkaline.

The upper part of the Bk horizon has value of 3 or 4 when moist and 5 or 6 when dry, and it has chroma of 3 or 4 when moist or dry. The lower part has value of 4 to 6 when moist and 6 to 8 when dry, and it has chroma of 2 or 3 when moist or dry. The horizon is mildly alkaline to strongly alkaline. It is 5 to 15 percent calcium carbonate.

Nansene Series

The Nansene series consists of deep, well drained soils on north-facing slopes of canyons. The soils formed in loess over basalt. Slopes are 35 to 70 percent. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Nansene silt loam in an area of Nansene-Rock outcrop complex, 35 to 70 percent north slopes; about 900 feet north and 2,450 feet east of the southwest corner of sec. 12, T. 1 N., R. 15 E.

A1—0 to 3 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak thin platy structure and weak very fine granular; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine interstitial pores; slightly acid (pH 6.5); abrupt wavy boundary.

A2—3 to 10 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak thick platy structure and weak medium granular; soft, very friable, slightly sticky and slightly plastic; common very fine roots; many very fine interstitial pores; neutral (pH 6.6); clear smooth boundary.

A3—10 to 20 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; neutral (pH 6.6); clear smooth boundary.

Bw—20 to 37 inches; very dark brown (10YR 2/2) silt loam, dark brown (10YR 4/3) dry; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; neutral (pH 6.6); clear smooth boundary.

C—37 to 54 inches; dark brown (10YR 3/3) silt loam, brown (10YR 4/3) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; neutral (pH 6.6); abrupt smooth boundary.

2R—54 inches; basalt.

The depth to bedrock is 40 to 60 inches. The mollic epipedon is 30 to 50 inches thick. The profile has hue of 10YR or 7.5YR.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry. The horizon is slightly acid or neutral.

The Bw horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry. The horizon is slightly acid to mildly alkaline.

The C horizon has value of 3 to 5 when moist and 4 to 7 when dry. It is weakly calcareous below a depth of 40 inches in some pedons. The horizon is neutral to moderately alkaline.

Pedigo Series

The Pedigo series consists of very deep, somewhat poorly drained soils on flood plains. The soils formed in alluvium. Slopes are 0 to 3 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Pedigo silt loam, 0 to 3 percent slopes; about 750 feet north and 500 feet west of the southeast corner of sec. 34, T. 3 S., R. 16 E.

Ak1—0 to 2 inches; dark brown (10YR 3/3) silt loam, grayish brown (10YR 5/2) dry; weak fine and very fine subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; many very fine roots; few fine tubular pores; strongly alkaline (pH 8.5); strongly effervescent; clear smooth boundary.

Ak2—2 to 7 inches; very dark brown (10YR 2/2) silt loam, dark gray (10YR 4/1) dry; weak fine and very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots and few fine roots; few fine tubular pores; moderately alkaline (pH 8.4); strongly effervescent; clear smooth boundary.

Ak3—7 to 16 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to weak fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots and few fine roots; few fine tubular pores; moderately alkaline (pH 8.4); strongly efffervescent; clear smooth boundary.

Ak4—16 to 21 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak fine subangular blocky structure; hard, very firm, sticky and plastic; many very fine roots; common fine tubular pores; moderately alkaline (pH 8.2); strongly effervescent; clear smooth boundary.

ACk—21 to 35 inches; dark gray (10YR 4/1) silt loam, gray (10YR 5/1) dry; weak fine subangular blocky structure; hard, very firm, sticky and plastic; many very fine roots; common fine tubular pores; moderately alkaline (pH 8.2); strongly effervescent; abrupt smooth boundary.

2C—35 to 60 inches; dark brown (10YR 4/3) very fine sandy loam, pale brown (10YR 6/3) dry; massive; soft, friable, nonsticky and nonplastic; few very fine and fine roots; many very fine interstitial pores; moderately alkaline (pH 8.2).

The depth to bedrock is more than 60 inches. The content of organic matter decreases irregularly as depth increases.

The Ak horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 1 or 2 when moist or dry. The upper part is strongly alkaline or very strongly alkaline, and the lower part ranges to moderately alkaline.

The 2C horizon has value of 3 or 4 when moist and 5 or 6 when dry, and it has chroma of 2 to 4 when moist or dry. The horizon is stratified very fine sandy loam to silty clay loam. It is moderately alkaline or strongly alkaline.

Quincy Series

The Quincy series consists of very deep, excessively drained soils on dunes and terraces. The soils formed in sand. Slopes are 5 to 25 percent. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Quincy loamy fine sand, 5 to 25 percent slopes; about 90 feet south and 330 feet east of the junction of U.S. Highway 30 and Frank Fulton Canyon Road; 1,190 feet north and 1,190 feet west of the southeast corner of sec. 8, T. 2 N., R. 16 E.

A—0 to 15 inches; dark brown (10YR 4/3) loamy fine sand, grayish brown (2.5Y 5/2) dry; weak thick platy structure parting to single grain; loose, nonsticky and nonplastic; common very fine roots; few very fine interstitial pores; neutral (pH 7.0); abrupt smooth boundary.

C—15 to 60 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; few very fine tubular pores; neutral (pH 7.2).

The depth to bedrock is more than 60 inches. The profile has hue of 10YR or 2.5Y, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 2 to 4 when moist or dry. It is slightly acid to moderately alkaline, increasing in alkalinity as depth increases.

The C horizon is loamy fine sand, fine sand, or sand.

Ritzville Series

The Ritzville series consists of deep, well drained soils on mesas. The soils formed in loess over basalt. Slopes are 2 to 15 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Ritzville silt loam, 2 to 7 percent slopes; about 600 feet north and 2,540 feet west of the southeast corner of sec. 34, T. 1 N., R. 19 E.

Ap—0 to 7 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; common fine interstitial and tubular pores; neutral (pH 6.6); abrupt smooth boundary.

AB—7 to 14 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many fine tubular pores; neutral (pH 6.8); gradual smooth boundary.

Bw—14 to 26 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many fine tubular pores; neutral (pH 6.9); gradual smooth boundary.

Bk1—26 to 42 inches; dark yellowish brown (10YR 4/4) silt loam, pale brown (10YR 6/3) dry; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many fine tubular pores; strongly effervescent with few segregated filaments of lime; mildly alkaline (pH 7.8); abrupt smooth boundary.

Bk2—42 to 45 inches; brown (10YR 5/3) silt loam, very pale brown (10YR 7/3) dry; massive; hard, very firm, slightly sticky and slightly plastic; few very fine roots; common fine and medium tubular pores; strongly effervescent with disseminated lime; moderately alkaline (pH 8.6); abrupt smooth boundary.

2R—45 inches; basalt.

The depth to bedrock is 40 to 60 inches. The depth to secondary lime is 20 to 30 inches.

The Ap and AB horizons have value of 4 or 5 when dry and chroma of 2 or 3 when moist or dry. They are neutral or mildly alkaline.

The Bw horizon has value of 3 or 4 when moist and 5 or 6 when dry, and it has chroma of 3 or 4 when moist or dry. The horizon is neutral or mildly alkaline.

The Bk horizon has value of 4 or 5 when moist and

6 or 7 when dry, and it has chroma of 3 or 4 when moist or dry. The horizon is mildly alkaline or moderately alkaline. It is 5 to 15 percent calcium carbonate.

Sagemoor Series

The Sagemoor series consists of very deep, well drained soils on dissected terraces. The soils formed in lacustrine deposits. Slopes are 5 to 40 percent. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Sagemoor silt loam, 20 to 40 percent south slopes, about 700 feet east of the bend in State Highway 206; 880 feet north and 300 feet east of the southwest corner of sec. 17, T. 1 S., R. 19 E.

A1—0 to 2 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak medium platy structure parting to weak fine granular; soft, very friable, nonsticky and slightly plastic; many very fine roots and common fine roots; many fine interstitial pores; neutral (pH 7.0); abrupt smooth boundary.

A2—2 to 4 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak thick platy structure parting to weak fine granular; soft, very friable, nonsticky and slightly plastic; many very fine roots and common fine roots; common fine continuous tubular pores; neutral (pH 7.2); clear smooth boundary.

Bw1—4 to 9 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, nonsticky and slightly plastic; many very fine roots and few fine and medium roots; common fine continuous tubular pores; neutral (pH 7.2); clear smooth boundary.

Bw2—9 to 24 inches; brown (10YR 5/3) silt loam, light gray (10YR 7/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots and few fine and medium roots; few fine tubular pores; mildly alkaline (pH 7.8); clear smooth boundary.

Bk1—24 to 42 inches; brown (10YR 5/3) silt loam, light gray (10YR 7/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; few fine tubular pores; strongly effervescent with disseminated lime; moderately alkaline (pH 8.2); clear smooth boundary.

Bk2—42 to 84 inches; brown (10YR 5/3) silt loam, light gray (10YR 7/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few fine tubular pores; strongly effervescent with disseminated and mycelial lime; strongly alkaline (pH 8.5)

The depth to bedrock is more than 60 inches. The depth to carbonates is 20 to 40 inches.

The A horizon has value of 3 or 4 when moist and 5 or 6 when dry, and it has chroma of 2 to 4 when moist or dry. The horizon is neutral or mildly alkaline.

The Bw horizon has value of 3 or 4 when moist and 5 to 7 when dry, and it has chroma of 2 or 3 when moist or dry. The horizon is silt loam or very fine sandy loam. It is neutral or mildly alkaline.

The Ck horizon has value of 4 or 5 when moist and 6 or 7 when dry. It is moderately alkaline or strongly alkaline. Lime is disseminated and in veins. The horizon is stratified silt loam and very fine sandy loam.

Walla Walla Series

The Walla Walla series consists of very deep and deep, well drained soils on mesas and canyons. The soils formed in loess over basalt. Slopes are 1 to 35 percent. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Walla Walla silt loam, 7 to 15 percent slopes (see fig. 8, next page), about 100 feet west of the 90-degree turn in county road; 25 feet north and 2,610 feet east of the southwest corner of sec. 25, T. 1 N., R. 16 E.

Ap1—0 to 7 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; weak thin platy structure parting to weak fine and medium granular; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many fine interstitial pores; neutral (pH 6.6); abrupt smooth boundary.

Ap2—7 to 9 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; moderate thick platy structure; slightly hard, firm, slighty sticky and slightly plastic; many very fine roots; many fine tubular pores; neutral (pH 6.7); abrupt smooth boundary.

A—9 to 17 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak coarse prismatic structure parting to weak medium subangular blocky; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many fine tubular pores; neutral (pH 6.8); clear wavy boundary.

Figure 8.—Typical pedon of Walla Walla silt loam, 7 to 15 percent slopes.

BA—17 to 25 inches; dark brown (10YR 4/3) silt loam, grayish brown (10YR 5/2) dry; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many fine tubular pores; neutral (pH 6.9); gradual wavy boundary.

Bw1—25 to 34 inches; dark brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; weak coarse prismatic structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many fine tubular pores; neutral (pH 6.9); gradual wavy boundary.

Bw2—34 to 50 inches; dark brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine and fine tubular pores; mildly alkaline (pH 7.4); gradual wavy boundary.

Bw3—50 to 66 inches; dark brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many fine tubular pores; mildly alkaline (pH 7.5).

The depth to bedrock is 40 to 60 inches or more. The profile is neutral or mildly alkaline. The depth to carbonates is more than 60 inches.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry.

The AB horizon have value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry.

The Bw horizon has value of 3 or 4 when moist and 5 or 6 when dry, and it has chroma of 3 or 4 when moist or dry.

Wato Series

The Wato series consists of very deep, well drained soils on mesas and canyons. The soils formed in loess. Slopes are 3 to 35 percent. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Wato very fine sandy loam, 3 to 7 percent slopes; about 1,650 feet south and 2,950 feet east of the northwest corner of sec. 26, T. 3 N., R. 17 E.

Ap—0 to 7 inches; very dark brown (10YR 2/2) very fine sandy loam, dark grayish brown (10YR 4/2) dry; weak thin platy structure parting to weak fine granular; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many fine interstitial pores; neutral (pH 6.6); abrupt smooth boundary.

A—7 to 13 inches; very dark brown (10YR 2/2) very fine sandy loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to weak coarse subangular blocky; soft, very friable, slightly sticky and slightly plastic; many very fine roots; common fine tubular pores; neutral (pH 6.6); abrupt smooth boundary.

Bw1—13 to 22 inches; dark brown (10YR 4/3) very fine sandy loam, brown (10YR 5/3) dry; weak coarse prismatic structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; neutral (pH 6.8); clear smooth boundary.

Bw2—22 to 35 inches; dark brown (10YR 4/3) very fine sandy loam, brown (10YR 5/3) dry; weak coarse prismatic structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; 10 percent gravel; neutral (pH 7.0); gradual smooth boundary.

Bw3—35 to 60 inches; dark brown (10YR 4/3) very fine sandy loam, pale brown (10YR 6/3) dry;

weak coarse prismatic structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; 10 percent gravel; neutral (pH 7.2).

The depth to bedrock is more than 60 inches. The depth to secondary lime, where present, is more than 40 inches. The profile is neutral or mildly alkaline throughout. It has hue of 10YR or 2.5Y.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry.

The Bw horizon has value of 2 to 5 when moist and 4 to 6 when dry, and it has chroma of 2 to 4 when moist or dry.

The C horizon, where present, has value of 4 to 6 when moist and 4 to 8 when dry, and it has chroma of 3 or 4 when moist or dry. A hard, firm, brittle layer of gravel is above the bedrock in some pedons.

Wrentham Series

The Wrentham series consists of moderately deep, well drained soils on canyons. The soils formed in loess over basalt. Slopes are 35 to 70 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Wrentham silt loam in an area of Wrentham-Rock outcrop complex, 35 to 70 percent north slopes; about 2,620 feet north and 1,800 feet west of the southeast corner of sec. 10, T. 3 S., R. 15 E.

A1—0 to 5 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak thin and medium platy structure parting to weak very fine granular; soft, very friable, slightly sticky and slightly plastic; many very fine roots; few very fine and fine irregular pores; 10 percent gravel; neutral (pH 6.6); clear smooth boundary.

A2—5 to 12 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; 10 percent gravel; neutral (pH 6.8); clear smooth boundary.

AB—12 to 17 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; 10 percent gravel; neutral (pH 7.0); gradual smooth boundary.

2Bw—17 to 32 inches; dark brown (10YR 3/3) extremely cobbly silt loam, yellowish brown (10YR 5/4) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; 40 percent cobbles and 20 percent gravel; neutral (pH 7.0); abrupt wavy boundary.

2R—32 inches; basalt.

The depth to bedrock is 20 to 40 inches.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 1 or 2 when moist or dry. The horizon is 0 to 15 percent gravel and 0 to 10 percent cobbles. The total content of rock fragments is 15 percent or less. The horizon is slightly acid or neutral.

The 2Bw horizon has value of 3 or 4 when moist and 4 or 5 when dry, and it has chroma of 2 to 4 when moist or dry. It is 20 to 60 percent cobbles and 5 to 50 percent gravel and is extremely cobbly silt loam or extremely gravelly silt loam.

Xerolls, Silty

Xerolls, silty, consists of very deep, somewhat poorly drained soils in basins on mesas. The soils formed in lacustrine sediment. Slopes are 0 to 3 percent. The mean annual precipitaion is about 11 inches, and the mean annual air temperature is about 49 degrees F.

Representative pedon of Xerolls, silty, 0 to 3 percent slopes; 2,100 feet south and 1,200 feet east of the northwest corner of sec. 14, T. 5 S., R. 17 E.

Ap1—0 to 2 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak thin platy structure; slightly hard, friable, nonsticky and slightly plastic; few very fine roots; common very fine vesicular pores; neutral (pH 7.0); clear smooth boundary.

Ap2—2 to 11 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots and few fine roots; many very fine vesicular pores; neutral (pH 7.0); clear wavy boundary.

Bt1—11 to 21 inches; very dark brown (10YR 2/2) silty clay loam, dark brown (10YR 4/3) dry; few fine faint strong brown (7.5YR 4/6) mottles; moderate medium prismatic structure parting to strong medium angular blocky; very hard, extremely firm, sticky and plastic; common very fine roots and few fine roots; few very fine tubular pores; few thin clay films on faces of peds and lining pores; mildly alkaline (pH 7.4); clear smooth boundary.

Bt2—21 to 32 inches; dark brown (10YR 3/3) silty clay loam, yellowish brown (10YR 5/4) dry; few fine faint strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure parting to fine subangular blocky; hard, very firm, slightly sticky and slightly plastic; few fine roots; few very fine tubular pores; few thin clay films on faces of peds and lining pores; mildly alkaline (pH 7.4); clear wavy boundary.

Bt3—32 to 40 inches; dark yellowish brown (10YR 3/4) silty clay loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; few very fine interstitial pores; few thin clay films on faces of peds and lining pores; mildly alkaline (pH 7.6); clear smooth boundary.

2C1—40 to 52 inches; dark yellowish brown (10YR 3/4) fine sandy loam, pale brown (10YR 6/3) dry; massive; slightly hard, friable, nonsticky and nonplastic; common very fine interstitial pores; mildly alkaline (pH 7.6); clear smooth boundary.

2C2—52 to 60 inches; dark brown (10YR 3/3) fine sandy loam, pale brown (10YR 6/3) dry; massive; slightly hard, friable, nonsticky and nonplastic; mildly alkaline (pH 7.6).

The depth to bedrock is more than 60 inches.

The Ap horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry.

The Bt horizon has value of 2 to 4 when moist and 4 to 6 when dry, and it has chroma of 3 or 4 when moist or dry. The horizon is neutral or mildly alkaline.

The 2C horizon has value of 3 or 4 when moist and 5 to 7 when dry, and it has chroma of 3 or 4 when moist or dry.

Formation of the Soils

Soil is the collection of natural bodies on the Earth's surface that contains living matter and is capable of supporting plants. The nature of a soil depends on the combination and interaction of five factors: (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and has existed since accumulation; (3) living organisms, mainly vegetation; (4) the relief, or lay of the land; and (5) the length of time the forces of development have acted on the material. There are innumerable combinations of these factors. The relative importance of each factor differs from place to place. On some landforms or landscape positions, one factor may be dominant in the formation of the soil and its associated properties. Generally, though, a combination of the five factors determines the characteristics of any soil. The five soil-forming factors and the morphology of the soils in the county are discussed in this section.

Parent Material

The soils in Sherman County formed in five kinds of parent material: (1) loess, (2) mixtures of volcanic ash and loess, (3) mixtures of loess and residuum and colluvium derived from basalt, (4) windblown sand, and (5) waterlaid deposits consisting of both stream alluvium and silty lake deposits. The two geologic formations that have influenced the soils are the Columbia River Basalt of the Miocene and the Shutler Formation of the Pliocene. The geology of the county is discussed in the section "General Nature of the County."

Loess is by far the most extensive parent material in the county, and it has influenced every major soil in the county to some extent. Loess is fine-grained, wind-deposited material consisting of dominantly of silt-sized particles.

The loess originated from glacial outwash deposited in the present channel of the Columbia River during the Pleistocene ice age. The loess accumulated mainly during warm periods when the glaciers melted. The sedimentation of outwash was at a maximum during these periods, and the soil surface was neither frozen nor blanketed with snow. Wind blowing from the northeast across the barren outwash lifted sand and silt particles into the airstream. The silt and very fine sand particles were carried toward the southwest and gradually settled throughout a wide area. Closer to the source, the deposits are coarser textured and thicker. Further south from the river, the deposits are finer textured and thinner.

Along roadcuts the loess is in vertical banks as much as 15 feet thick. This phenomenon, peculiar to loess but common wherever loess occurs, results when the individual plate-shaped particles are laid down horizontally, much like the pages of a book.

Loess contains a wide variety of easily weathered minerals, and its qualities generally result in naturally fertile soils. Anderly, Anders, Condon, Mikkalo, Nansene, Ritzville, Walla Walla, and Wato soils formed in loess.

At one or more times during the deposition of the loess, volcanic ash also was deposited in the county. It came from the now dormant and extinct volcanoes of the Cascade Mountains. All of the soils in the county probably contain some volcanic ash, which consists of sharp-edged, sand- to silt-sized particles of silica, feldspar, glass, and other material. Because volcanic ash is extremely susceptible to movement by both wind and water, nearly all of the original deposits have been removed from uplands and redeposited along streams, or they have been blown away or washed away. Only remnants, mostly those intermixed with loess, remain. The Cantala soils formed in material that is high in content of volcanic ash. Many areas of the Hermiston soils, which formed in alluvium, contain a layer that is high in content of volcanic ash.

The Bakeoven, Kuhl, Lickskillet, and Wrentham soils formed in a mixture of loess and basalt derived from residuum and colluvium.

The Quincy soils formed in eolian sand along the Columbia River. The sand originally was deposited by water and may be a remnant of the glacial outwash that once filled the Columbia River Gorge, but it has been reworked and shifted by the wind.

The Endersby, Hermiston, Pedigo, and Sagemoor soils formed in material deposited by water. The Endersby soils, which are on stream terraces, formed in sandy sediment over water-worked gravel and cobbles. The Hermiston soils, which are on flood plains, formed in silty sediment that is from the loessal uplands and is mixed with volcanic ash and material derived from basalt. The wet, sodic Pedigo soils, which are of minor extent in the county, formed in similar material. The Sagemoor soils, which are on highly dissected terraces, formed in lacustrine deposits, most of which were washed away when the level of the lake apparently dropped rapidly.

Climate

The climate of the county is mainly semi-arid, and most of the annual precipitation falls in winter. Climate affects the kind and amount of native vegetation. The climate is fairly uniform throughout the county. The average annual air temperature is 48 to 51 degrees F. The upper few inches of the soils are frozen for some period in winter, and daily freezing and thawing are common on the south-facing slopes. Temperatures in summer are cool.

The total amount of precipitation and season of distribution are such that most soils become thoroughly dry in summer for at least 60 days during most years. The average annual precipitation ranges from about 13 inches in the northwestern part of the county to about 9 inches in the eastern and southern parts. Approximately 60 percent of the precipitation falls during the coldest months, November through March, when chemical and biological activity are at a minimum. The rate of soil development, which depends largely on chemical and biological activity, is slower than it would be if more of the precipitation fell during the warmer months. The soils are dry during July and August, and soil development virtually stops.

Living Organisms

Sherman County is the only county in Oregon that does not support forests. When the first settlers arrived, the vegetation consisted mainly of bunchgrass. The only trees present were a few cottonwoods and willows scattered along the streams and a few junipers in the outcroppings of bedrock.

There are four main plant communities in the county. They are identified by the dominant forage species. In order of those that require the most moisture to those that require the least, the plant communities are (1) Idaho fescue-bluebunch wheatgrass, (2) bluebunch wheatgrass-Idaho fescue, (3) bluebunch wheatgrass-Sandberg bluegrass, and (4) Sandberg bluegrass-bluebunch wheatgrass. Soils that formed under the Idaho fescue-bluebunch wheatgrass community have the highest organic matter content, and those that formed under the Sandberg bluegrass-bluebunch wheatgrass community have the lowest.

Plant communities of minor extent in the county are (1) saltgrass-giant wildrye, (2) bluebunch wheatgrass-giant wildrye, and (3) needlegrass-bluebunch wheatgrass.

Micro-organisms and other living organisms except grasses have played a minor role in soil development in the county. In some places burrowing animals have slowed down horizonation by mixing genetic layers that have already formed. Man has significantly influenced soil formation. As a result of repeated tillage operations, the content of organic matter in the surface layer has been reduced and the structure of the surface layer has been weakened.

Topography

Sherman County is a small part of a large basalt plateau. The faulting, fracturing, and incising of this plateau has resulted in the formation of many canyons. The most striking relief occurs as canyons along major fault lines. Along the major drainageways at the bottom of the canyons, the topography consists of narrow bands of nearly level flood plains and stream terraces. Away from the major drainageways, the topography consists of gently sloping to strongly sloping mesas.

Directly or indirectly, the topography of the county has resulted in significant differences in the soils. The kind of parent material in an area is determined mainly by topography. Soils on very steep slopes commonly formed in basalt colluvium. Alluvial soils on narrow, nearly level flood plains and terraces formed in wind- and water-deposited material eroded from uplands. The soils that formed in silty lake deposits are at elevations at or below the level of former lakes. The depth and texture of loessal deposits are determined by the distance from the source and by aspect.

Aspect is one of the most important features of topography that affects soil formation. Soils on south-facing slopes are warmer and drier, have less natural vegetation, have a lower content of organic matter, are shallower to bedrock, and have a thinner mantle of loess than those on north-facing slopes.

Another important feature of topography is slope gradient. Soils that have very steep slopes are shallower and have less distinct horizons than those that have gentle slopes.

Time

The length of time that parent material has been subject to weathering, in combination with the other factors, plays a significant role in soil formation. Other things being equal, younger soils have less horizon differentiation than older soils. For example, Hermiston and Sagemoor soils formed in recent alluvial and lacustrine sediment, and although leaching has been strong enough to concentrate carbonates below a depth of about 20 inches, a B horizon has not formed. Lickskillet and Wrentham soils formed in areas that receive less precipitation, but they have a distinct B horizon because they have been in place longer.

Morphology of the Soils

A soil is not easily studied in its natural position because only the surface is exposed. To see and study a soil, it is necessary to expose a profile, which generally consists of several horizons.

In Sherman County the differentiation of horizons is a result of an accumulation of organic matter in the A horizon; high base saturation with the retention of calcium, potassium, and magnesium; accumulation or retention of calcium carbonates in the lower horizons; and accumulation of exchangeable sodium.

Organic matter has accumulated in the upper part of all of the soils in the county forming an A horizon. The content of organic matter is lowest in the Bakeoven, Quincy, and Sagemoor soils and highest in the Nansene and Wrentham soils. The removal of native vegetation from many soils and the subsequent reduction in organic matter as a result of a summer-fallow system of farming have markedly changed the structure and water-absorbing ability of the A horizon. Surface crusting, vesicular porosity, and massive or platy structure are common in the A horizon of cultivated soils.

All of the soils in the county have moderate or high base saturation. Although no specific data is available, the Sagemoor soils probably have the highest base saturation and the Nansene and Wrentham soils probably have the lowest.

There is visible evidence of leaching of carbonates and salts in some of the soils in the county. The Sagemoor soils, which have been leached the least, have an accumulation of calcium carbonates below a depth of 20 inches. The Nansene and Wrentham soils have been leached the most, and they generally contain no free carbonates.

The Pedigo soils have high sodium saturation, which is exhibited by reaction (pH) of more than 8.4 in the surface layer.

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Alpha, alpha-dipyridyl. A dye that when dissolved in 1N ammonium acetate is used to detect the presence of reduced iron (Fe II) in the soil. A positive reaction indicates a type of redoximorphic feature.

Animal unit month (AUM). The amount of forage required by one mature cow of approximately 1,000 pounds weight, with or without a calf, for 1 month.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Argillic horizon. A subsoil horizon characterized by an accumulation of illuvial clay.

Aspect. The direction in which a slope faces.

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 a numerical range in the map unit description.

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, and 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.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Brush management. Use of mechanical, chemical, or biological methods to make conditions favorable for reseeding or to reduce or eliminate competition from woody vegetation and thus allow understory grasses and forbs to recover. Brush management increases forage production and thus reduces the hazard of erosion. It can improve the habitat for some species of wildlife.

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

Caliche. A more or less cemented deposit of calcium carbonate in soils of warm-temperate, subhumid to arid areas. Caliche occurs as soft, thin layers in the soil or as hard, thick beds directly beneath the solum, or it is exposed at the surface by erosion.

Canyon. A long, deep, narrow, very steep sided valley with high, precipitous walls in an area of high local relief.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

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.

Chemical treatment. Control of unwanted vegetation through the use of chemicals.

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.

Climax plant community. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse textured soil. Sand or loamy sand.

Cobble (or cobblestone). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Cobbly soil material. Material that is 15 to 35 percent, by volume, rounded or partially rounded rock fragments 3 to 10 inches (7.6 to 25 centimeters) in diameter. Very cobbly soil material has 35 to 60 percent of these rock fragments, and extremely cobbly soil material has more than 60 percent.

Colluvium. Soil material or 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 establishing terraces, diversions, and other water-control structures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil or miscellaneous areas in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas.

Conservation cropping system. Growing crops in combination with needed cultural and management practices. In a good conservation cropping system, the soil-improving crops and practices more than offset the effects of the soil-depleting crops and practices. Cropping systems are needed on all tilled soils. Soil-improving practices in a conservation cropping system include the use of rotations that contain grasses and legumes and the return of crop residue to the soil. Other practices include the use of green manure crops of grasses and legumes, proper tillage, adequate fertilization, and weed and pest control.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. Refers to the degree of cohesion and adhesion of soil material and its resistance to deformation when ruptured. Consistence includes resistance of soil material to rupture and to penetration; plasticity, toughness, and stickiness of puddled soil material; and the manner in which the soil material behaves when subject to compression. Terms describing consistence are defined in the “Soil Survey Manual.”

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosion. Soil-induced electrochemical or chemical action that dissolves or weakens concrete or uncoated steel.

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.

Cropping system. Growing crops according to a planned system of rotation and management practices.

Crop residue management. Returning crop residue to the soil, which helps to maintain soil structure, organic matter content, and fertility and helps to control erosion.

Cross-slope farming. Deliberately conducting farming operations on sloping farmland in such a way that tillage is across the general slope.

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. Generally, the thickness of the soil over bedrock. Very deep soils are more than 60 inches deep over bedrock; deep soils, 40 to 60 inches; moderately deep, 20 to 40 inches; shallow, 10 to 20 inches; and very shallow, less than 10 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.

Divided-slope farming. A form of field stripcropping in which crops are grown in a systematic arrangement of two strips, or bands, across the slope to reduce the hazard of water erosion. One strip is in a close-growing crop that provides protection from erosion, and the other strip is in a crop that provides less protection from erosion. This practice is used where slopes are not long enough to permit a full stripcropping pattern to be used.

Drainage class (natural). Refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized—*excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained,* and *very poorly drained*. These classes are defined in the "Soil Survey Manual."

Drainage, surface. Runoff, or surface flow of water, from an area.

Duff. A generally firm organic layer on the surface of mineral soils. It consists of fallen plant material that is in the process of decomposition and includes everything from the litter on the surface to underlying pure humus.

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

Ephemeral stream. A stream, or reach of a stream, that flows only in direct response to precipitation. It receives no long-continued supply from melting snow or other source, and its channel is above the water table at all times.

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 human or animal activities or of a catastrophe in nature, such as a fire, that exposes the surface.

Escarpment. A relatively continuous and steep slope or cliff breaking the general continuity of more gently sloping land surfaces and resulting from erosion or faulting. Synonym: scarp.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grain is grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

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, or clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Fluvial. Of or pertaining to rivers; produced by river action, as a fluvial plain.

Foothill. A steeply sloping upland that has relief of as much as 1,000 feet (300 meters) and fringes a mountain range or high-plateau escarpment.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Fragile (in tables). A soil that is easily damaged by use or disturbance.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial outwash. Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glaciofluvial deposits. Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Graded stripcropping. Growing crops in strips that grade toward a protected waterway.

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 as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 35 percent, by volume, rounded or angular rock fragments, not prominently flattened, as much as 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water. Water filling all the unblocked pores of the 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.

Hard bedrock. Bedrock that cannot be excavated except by blasting or by the use of special equipment that is not commonly used in construction.

Head out. To form a flower head.

High-residue crops. Such crops as small grain and corn used for grain. If properly managed, residue from these crops can be used to control erosion until the next crop in the rotation is established. These crops return large amounts of organic matter to the soil.

Hill. A natural elevation of the land surface, rising as much as 1,000 feet above surrounding lowlands, commonly of limited summit area and having a well defined outline; hillsides generally have slopes of more than 15 percent. The distinction between a hill and a mountain is arbitrary and is dependent on local usage.

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. An explanation of the subdivisions is given in the “Soil Survey Manual.” The major horizons of mineral soil are as follows:

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

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 soil material. 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.—Consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but it can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff potential. The soil properties that influence this potential are those that affect the minimum rate of water infiltration on a bare soil during periods after prolonged wetting when the soil is not frozen. These properties are depth to a seasonal high water table, the infiltration rate and permeability after prolonged wetting, and depth to a very slowly permeable layer. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff.

Igneous rock. Rock formed by solidification from a molten or partially molten state. Major varieties include plutonic and volcanic rock. Examples are andesite, basalt, and granite.

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.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

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 capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

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

Intermittent stream. A stream, or reach of a stream, that flows for prolonged periods only when it receives ground-water discharge or long, continued contributions from melting snow or other surface and shallow subsurface sources.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, plants invade following 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.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Lacustrine deposit. Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Landslide. The rapid downhill movement of a mass of soil and loose rock, generally when wet or saturated. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

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.

Mechanical treatment. Use of mechanical equipment for seeding, brush management, and other management practices.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mesa. A broad, nearly flat topped and commonly isolated upland mass characterized by summit widths that are more than the heights of bounding erosional scarps.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, or silty clay loam.

Mollic epipedon. A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.

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. 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).

Mountain. A natural elevation of the land surface, rising more than 1,000 feet above surrounding lowlands, commonly of restricted summit area (relative to a plateau) and generally having steep sides. A mountain can occur as a single, isolated mass or in a group forming a chain or range.

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value of 6.6 to 7.3. (See Reaction, soil.)

Nodules. Cemented bodies lacking visible internal structure. Calcium carbonate, iron oxide, and manganese oxide are common compounds making up nodules. If formed in place, nodules of iron oxide or manganese oxide are considered types of redoximorphic concentrations.

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 content of organic matter in the surface layer is described as follows:

Very low	less than 0.5 percent
Low	0.5 to 1.0 percent
Moderately low	1.0 to 2.0 percent
Moderate	2.0 to 4.0 percent
High	4.0 to 8.0 percent
Very high	more than 8.0 percent

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it generally is low in relief.

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan*.

Parent material. The unconsolidated organic and mineral material in which soil forms.

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.

Percs slowly (in tables). The slow movement of water through the soil adversely affects the specified use.

Permeability. The quality of the soil that enables water or air to move downward through the profile. The rate at which a saturated soil transmits water is accepted as a measure of this quality. In soil physics, the rate is referred to as "saturated hydraulic conductivity," which is defined in the "Soil Survey Manual." In line with conventional usage in the engineering profession and with traditional usage in published soil surveys, this rate of flow continues to be expressed as "permeability." Terms describing permeability, measured in inches per hour, are as follows:

Extremely slow	0.0 to 0.01 inch
Very slow	0.01 to 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, such as slope, stoniness, and flooding.

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.

Plateau. An extensive upland mass with relatively flat summit area that is considerably elevated (more than 100 meters) above adjacent lowlands and separated from them on one or more sides by escarpments.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Potential native plant community. See Climax plant community.

Potential rooting depth (effective rooting depth). Depth to which roots could penetrate if the content of moisture in the soil were adequate. The soil has no properties restricting the penetration of roots to this depth.

Prescribed burning. Deliberately burning an area for specific management purposes, under the appropriate conditions of weather and soil moisture and at the proper time of day.

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.

Proper grazing use. Grazing at an intensity that maintains enough cover to protect the soil and maintain or improve the quantity and quality of the desirable vegetation. This practice increases the vigor and reproduction capacity of the key plants and promotes the accumulation of litter and mulch necessary to conserve soil and water.

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.

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 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 degrees of acidity or alkalinity, expressed as pH values, are:

Ultra acid	less than 3.5
Extremely acid	3.5 to 4.4
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Moderately 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

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth’s surface; the loose earth material above the solid rock.

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

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep-sided channel resulting from accelerated erosion. A rill generally is a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0

millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-sized particles.

Saprolite. Unconsolidated residual material underlying the soil and grading to hard bedrock below.

Saturation. Wetness characterized by zero or positive pressure of the soil water. Under conditions of saturation, the water will flow from the soil matrix into an unlined auger hole.

Scarification. The act of abrading, scratching, loosening, crushing, or modifying the surface to increase water absorption or to provide a more tillable soil.

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. 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.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

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.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Sinkhole. A depression in the landscape where limestone has been dissolved.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

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, classes for simple slopes are as follows:

Nearly level	0 to 3 percent
Gently sloping	1 to 7 percent
Strongly sloping	7 to 15 percent
Steep	15 to 40 percent
Very steep	40 percent and higher

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Sodic (alkali) 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.

Soft bedrock. Bedrock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

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, in millimeters, of separates recognized in the United States are as follows:

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 material below the solum. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands that provide vegetative barriers to wind erosion and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind erosion and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

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

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, or AB) below the surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Talus. Fragments of rock and other soil material accumulated by gravity at the foot of cliffs or steep slopes.

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. A terrace in a field generally is built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

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

Thin layer (in tables). Otherwise suitable soil material that is too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Too arid (in tables). The soil is dry most of the time, and vegetation is difficult to establish.

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, in soils in extremely small amounts. They are essential to plant growth.

Tuff. A compacted deposit that is 50 percent or more volcanic ash and dust.

Upland. Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

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 a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.